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THERMAL ANALYSIS OF PANSAT
ELECTRIC POWER SUBSYSTEM

by

Eric L. Victor

June, 1994

Thesis Advisor: I. Michael Ross

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	16 June 1994	Master's Thesis

4. TITLE AND SUBTITLE Thermal Analysis of PANSAT Electric Power Subsystem	5. FUNDING NUMBERS
6. AUTHOR(S) Victor, Eric L.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Approved for public release; distribution is unlimited.	A

13. ABSTRACT *(maximum 200 words)*

Spacecraft thermal-control subsystems are necessary to maintain all elements of a spacecraft system within their temperature limits for all mission phases. In most instances the heat inputs are highly variable with time, requiring thorough transient-analysis of thermal flow within the spacecraft. Additionally, steady-state thermal profiles are necessary for precise overall thermal-analysis. The objective of this thesis is to develop a steady-state thermal model of the Electric Power Subsystem (EPS) and its associated housing for the Petite Amateur Navy Satellite (PANSAT). This task is undertaken to identify any physical locations within the EPS where temperatures exceed the limits established to protect sensitive electronic components. Software generated steady-state analysis using only contact-conductances for the EPS through the housing attachment is performed. It is shown that given the geometry of the physical model, the conductive relations developed, and the given boundary conditions, the steady-state temperature of the EPS and its associated housing will remain within limits.

14. SUBJECT TERMS PANSAT; Thermal, Electric, Conduction, ITAS, Material, Printed circuit boards, Nodes, Steady-state, Temperature	15. NUMBER OF PAGES 105
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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THERMAL ANALYSIS OF PANSAT ELECTRIC POWER SUBSYSTEM

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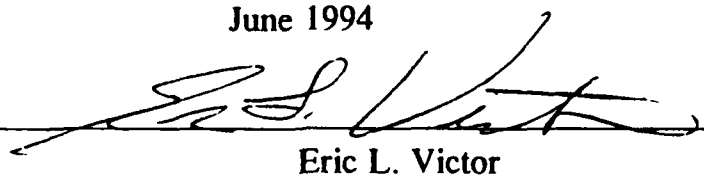
Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
June 1994

Author: 
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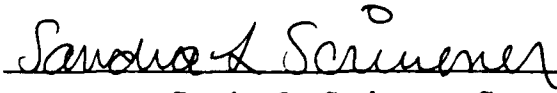
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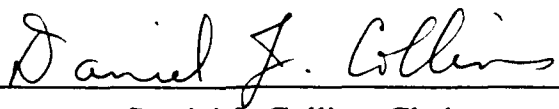
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ABSTRACT

Spacecraft thermal-control subsystems are necessary to maintain all elements of a spacecraft system within their temperature limits for all mission phases. In most instances the heat inputs are highly variable with time, requiring thorough transient-analysis of thermal flow within the spacecraft. Additionally, steady-state thermal profiles are necessary for precise overall thermal-analysis. The objective of this thesis is to develop a steady-state thermal model of the Electric Power Subsystem (EPS) and its associated housing for the Petite Amateur Navy Satellite (PANSAT). This task is undertaken to identify any physical locations within the EPS where temperatures exceed the limits established to protect sensitive electronic components. Software generated steady-state analysis using only contact-conductances for the EPS through the housing attachment is performed. It is shown that given the geometry of the physical model, the conductive relations developed, and the given boundary conditions, the steady-state temperature of the EPS and its associated housing will remain within limits.

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I. INTRODUCTION

In order to maintain all the elements of a spacecraft system within their temperature limits for all mission phases, thermal analysis of individual spacecraft subsystems is necessary for thermal-control subsystem design. Thermal-control designers must account for heat inputs from several sources, such as the Sun, the Earth, and electrical and electronic components on-board the spacecraft. In most instances the heat inputs are highly variable with time, requiring thorough transient-analysis of thermal flow within the spacecraft. Additionally, steady-state thermal profiles are necessary for overall thermal analysis. During the preliminary mission design of a spacecraft there are several thermal issues which must be addressed. A review of these issues bounds the thermal design problem. The first step in the thermal design of a spacecraft is to determine key requirements and constraints, which include the temperature limits and power dissipation of all spacecraft components. Next, spacecraft altitude and orientation relative to the Earth and Sun for all mission phases is determined in order to calculate the minimum and maximum thermal flux from each of these celestial bodies. With this, environmental heat inputs on the exterior surfaces of the spacecraft can be calculated. Once thermal boundary conditions are established, temperature limits defined, software modeling developed, and any other miscellaneous requirements understood, a complete spacecraft thermal subsystem can be developed.

A. THESIS SCOPE

The purpose of this thesis is to develop a steady-state thermal model of the Electric Power Subsystem (EPS) and its associated housing for the Petite Amateur Navy Satellite (PANSAT). This task is undertaken in order to identify any physical locations within the EPS where temperatures exceed the limits established to protect sensitive electronic components. Software generated steady-state analysis using only contact conductances through the housing attachment is studied to pinpoint any physical locations that deviate from the allowable temperature ranges. To generate the data needed for analysis it was necessary to determine circuit board layouts, which

included component locations and board sizes, in addition to power dissipation requirements of individual components. From this information, thermal nodes and thermal conductivities between nodes were calculated. Inward-viewing box geometry was created to physically model the EPS. Finally, the EPS housing was sized for thickness and structural integrity for a dynamic environment with an emphasis on thermal concerns.

B. BACKGROUND

A basic understanding of thermal conductivity and of the Integrated Thermal Analysis System (ITAS) software used to thermally model the EPS is necessary to appreciate the scope of this thesis.

1. Heat Conduction

a. Conduction

Whenever a temperature gradient exists in a solid medium, heat will flow from the higher-temperature to the lower-temperature region. The rate at which heat is transferred by conduction is proportional to the temperature gradient multiplied by the area of flux through which heat is being transferred:

$$q = A\frac{dT}{dx} \tag{1}$$

The actual rate of heat flow depends on the thermal conductivity, k, which is a physical property of the medium. For conduction through a homogeneous medium, the rate of heat transfer is then:

$$q = -kA\frac{dT}{dx} \tag{2}$$

The minus sign is included as a result of the second law of thermodynamics which requires that heat must flow from a higher-temperature region to a lower-temperature region. Equation (2) provides the definition for the thermal conductivity, k, and is called Fourier's Law of Conduction in honor of the French scientist J.B.J. Fourier, who proposed it in 1822. The thermal conductivity is a material property that indicates the amount of heat that will flow per unit time across a unit area when the temperature gradient is unity. Although, in general, the thermal conductivity varies

with temperature, in many engineering problems the variation is sufficiently small to be neglected For engineering calculations, experimentally measured values of thermal conductivity are used [Ref. 1: p 4-8]

The best thermal conductors are metallic solids and the poorest ones are gases. In between lie alloys, nonmetallic solids, and liquids. Solid materials consist of free electrons and of atoms in a periodic lattice arrangement. Thermal energy may thus be conducted by two mechanisms: migration of free electrons and lattice vibration. These two effects are additive, but, in general, the transport due to electrons is more effective than the transport due to vibrational energy in the lattice structure. Since electrons transport electric charge in a manner similar to the way in which they carry thermal energy from a higher-temperature region to a lower-temperature region, good electrical conductors are usually also good heat conductors and good electrical insulators are poor heat conductors. In non-metallic solids there is little or no electronic transport and the conductivity is therefore primarily determined by lattice vibration. This explains why these materials have a lower thermal conductivity than metals. An important group of solid materials for heat transfer design are thermal insulators. These materials are solids, but their structure contains air spaces that are sufficiently small to suppress gaseous motion and thus take advantage of the low thermal conductivity of gases in reducing heat transfer. Although we usually speak of a thermal conductivity of thermal insulators, in reality the transport through an insulator is comprised of conduction as well as radiation across the interstices filled with gas. In good insulators the spaces containing the air are sealed from each other, as in cellular foams made from plastic or glass. The thermal conductivity value of insulation systems is always an effective value that accounts for conduction, radiation, and sometimes also convection within the material. [Ref. 1: p. 10-12]

b. Thermal Conductance

To establish the working equation for thermal conductance that will be used in calculations for this thesis, examine the simple case of steady-state heat flow through a plane wall with a non-varying temperature gradient and non-varying heat flow through a uniform cross-sectional area. Using these assumptions and integrating equation (2) we obtain:

$$q = \frac{T_{hot} - T_{cold}}{L / Ak} \qquad (3)$$

In this equation, $(T_{hot} - T_{cold})$, the difference between the higher-temperature region and the lower-temperature region is the driving potential that causes the flow of heat. The quantity (L/Ak) is equivalent to a thermal resistance, R, that the theoretical wall offers to the flow of heat by conduction, thus:

$$R = L / A k \qquad (4)$$

The reciprocal of the thermal resistance is referred to as the thermal conductance, K, defined by: [Ref. 1: p. 6.7]

$$K = A k / L \qquad (5)$$

c. Contact Resistance

When different conducting surfaces are placed in contact, a thermal resistance is present at the interface of the solids. The interface resistance, frequently called the contact resistance, is developed when two materials will not fit tightly together and a thin layer of fluid is trapped between them. Examination of an enlarged view of the contact between two surfaces shows that the solids touch only at the peaks in the surface and that the valleys in the mating surfaces are occupied by a gas (possibly air), a liquid, or a vacuum. The following parameters are of primary importance:

- Geometry of the contacting material: surface roughness
- Thickness of the gap
- Type of interstitial fluid: gas, liquid, grease, vacuum
- Thermal conductivities of materials
- Microhardness of surface materials
- Contact pressure
- Apparent contact area
- Temperature

At the interface, the mechanism of heat transfer is complex. Conductance takes place through the contact points of the solids, while heat is transferred by convection and radiation across the trapped interstitial fluid. [Ref. 1: p. 12]

It is difficult to determine the surface quality of a material. Surface qualities include its geometry, crystal structure, appearance, color, resistance to corrosion, hardness (microhardness), and size and shape of surface flaws. The surface deviations determine the surface roughness. There are three types of surface deviations: surface flaws, waviness, and roughness. Surface flaws are occasional irregularities; waviness consists of widely spaced irregularities such as feed marks, and roughness consists of finely spaced irregularities (less than 1/32 in.) which determine the 'finish' of a surface. The average height of surface irregularities is a measure of roughness but not a complete specification of the character of the irregularities. A preferred set of roughness classes has been suggested from 1/4 in. to 63,000 microin., as average. [Ref. 2: p.13-65]

Hardness of materials has been variously defined as resistance to local penetration, to scratching, to machining, to wear or abrasions, and to yielding. The multiplicity of definitions and corresponding multiplicity of hardness measuring instruments, together with the lack of a fundamental definition, indicates that hardness may not be a fundamental property of a material but rather a composite one including yield strength, work hardening, true tensile strength, modulus of elasticity, and others. The resistance to localized penetration, or indentation hardness, is widely used industrially as a measure of hardness and is the one measure used for this thesis.[Ref. 2: p.5-15]

There are several indentation tests commonly utilized. The Brinell hardness is determined by forcing a hardened sphere under a known load into the surface of a material and measuring the diameter of the indentation left after the test. The Brinell hardness number is obtained by dividing the load used, in kilograms, by the actual surface area of the indentation, in square millimeters. The result is a pressure, but the units are rarely stated. In the standard Brinell test, the diameter of the impression is measured with a low-power hand microscope, but for production work there are available several testing machines which automatically measure the depth of the impression and from this give readings of hardness.

In the Rockwell method of hardness testing, the depth of penetration of an indentor under certain arbitrary conditions of test is determined. The indentor may be either a steel ball of some specified diameter or a spherical-tipped conical diamond of 120 deg. angle and 0.2 mm tip

radius, called a "Brale". A minor load of 10 kg is first applied which causes an initial penetration and holds the indentor in place. Under this condition, the depth-measuring scale is set to its arbitrary maximum value of 130 if any of the balls are used, or to 100 if the Brale is used. A major load of 60, 100, or 150 kg is then applied under dashpot control and then removed, returning to the minor load of 10 kg. The hardness number may then be read directly from the scale which measures penetration, and this scale is so arranged that soft materials with deep penetrations give low-hardness numbers. As compared with the Brinell test, the Rockwell method makes a smaller indentation, may be used on thinner material, and is much more rapid since hardness numbers are read directly and need not be calculated. The relation among the scales of various hardness methods is not exact, since no two measure exactly the same sort of hardness, and a relationship determined on steels of different hardnesses is only approximately true with other materials. The Brinell-Rockwell relation is fairly satisfactory and is shown in Figure 1. [Ref. 2: p. 5-16]

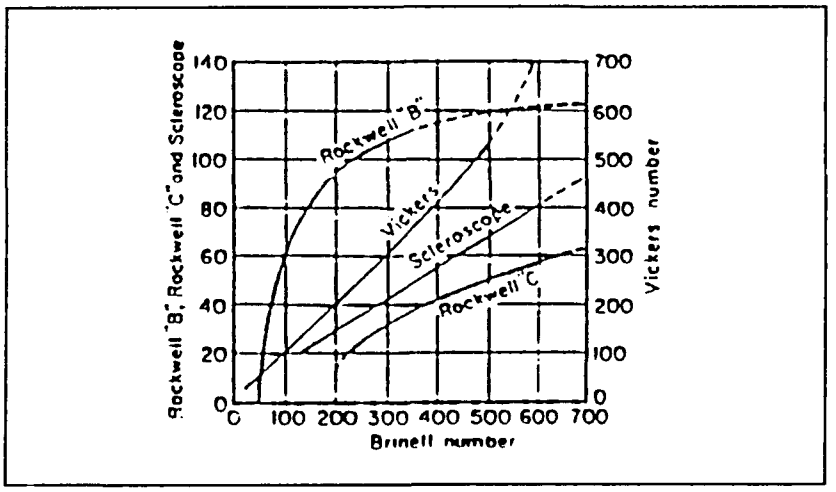


Figure 1. Hardness Scales

d. Joint Conductance

What follows in this section is based on work in thermal contact by Professor M.M. Yovanovich of the University of Waterloo, in Waterloo, Ontario.

Once the microhardness, H, the thermal conductivity, k, and surface roughness, S_r, are determined for both surfaces, and interstitial fluid trapped between the two surfaces, if any, is identified, we can proceed with calculations to determine the joint conductance. Additional

information required includes the contact pressure of the surfaces, P, the apparent contact area of the two surfaces, A_a, and temperature of the surfaces. We define the joint conductance, h, as follows with h_c being the contact conductance and h_g being the gap conductance:

$$h = h_c + h_g \tag{6}$$

(1) Contact Conductance. The first step in calculating the contact conductance is to determine the mean thermal conductivity, k_s, of the two surfaces:

$$k_s = \frac{2(k_1)(k_2)}{k_1 + k_2} \tag{7}$$

The hardness of the softer material is then utilized to find P/H. The value for P/H and the measured readings for surface roughness of the materials are input into the following equation which is then solved for h_c, the contact conductance:

$$h_c = \frac{(1.25)k_s[P/H]^{.95}}{S_r} \tag{8}$$

(2) Gap Conductance. For a complete explanation and derivation for the gap conductance, refer to works by Professor Yovanovich. For the purposes of this thesis, the interstitial space is assumed to be a vacuum and h_g, the gap conductance, is assumed to be zero.

2. Integrated Thermal Analysis System

The Integrated Thermal Analysis System (ITAS) was developed by the Analytix Corporation in 1988. ITAS was developed to assist spacecraft designers in all tasks in thermal design modeling from geometry generation to results post-processing for various engineering computations. These computations include orbital analysis, thermal analysis, contamination evolution, plume impingement, etc. The current interactive version of the code fully supports all capabilities relevant to the spacecraft thermal analysis, namely, view factors (contour integration and ray tracing), shadow factors (blockage), on-orbit incident flux determination for various orientations, radiation interchange factors, on-orbit absorbed heat-rates calculations in addition to steady-state and/or transient temperature computations. There are other capabilities that may be reviewed in the ITAS Users Manual and are not discussed further here.

ITAS is an integrated, interactive, and fairly user-friendly code. Once started, the user may select various options from well designed color menus, depending on the purpose, to calculate or plot various parameters interactively. No special compiler or linker program is necessary to run ITAS, which simplifies the loading and running of the main program. No in-depth knowledge of DOS is required, although an understanding of the basic concepts of heat transfer is necessary for some user provided calculations.

Utilizing ITAS begins with generation of the geometric model. ITAS may be used to interactively generate surface geometry models from "primitives" (basic shapes). These shapes include polygons, boxes, disc's, cones, cylinders, paraboloids, spheres, any generic surface of revolution, generic boxes of any cross-section, and elbows of any angle. All shapes generated are stored in a file called a PARTS file. A PARTS file may consist of 1000 or more parts (the number of parts is limited only by the available disc space) and any number of parts may be chosen for building a geometric model. The parts generated may then be selectively plotted for model building. Once a model is displayed on the screen, surface node numbers and user-assigned thermal node numbers are assigned to the active surfaces in the geometric model.

Once the geometric model is built and surface nodes generated, material properties may be assigned to each surface or node via a reference number from the internal ITAS material property library. Two sets of material property libraries may be accessed from within the ITAS: the optical characteristics library and the physical property library.

The optical library currently contains about four hundred solar absorbtivity and emissivity pairs for coatings and other surfaces and their finishes from white paint to many variations of metallic surfaces. The optical property library may be accessed from different locations within the program, enabling the user to utilize the information within without leaving the main routine. When a material I.D. is entered for a particular surface, the program will automatically assign those optical properties to the surface for all calculations. The contents of the library may be updated by the user.

The physical property library provides information-only data to the user. There are over eleven hundred material entries in this library. The following material properties may be obtained

from this database: thermal conductivity, specific heat, density, latent heat, and maximum or transition temperatures of a specific material. Some of these values are later used in calculations for conductive relationships. Once the geometric model with ITAS generated surface nodes and their associated material properties are entered, then user-defined nodes are entered by the user.

User-nodes are non-geometric nodes and, therefore, do not have any "physical" presence (surface) in ITAS. These nodes are used for mathematically connecting all the surfaces in the geometric model and any other surfaces the user desires. Three types of thermal nodes are allowed in ITAS. First, Diffusion nodes are nodes with finite masses; Second, a Boundary node is a node where the temperature remains fixed at all times; Third, an Arithmetic node is a node with zero mass. The temperature response of an Arithmetic node is instantaneous. Arithmetic nodes exist mathematically in ITAS only, not as physical nodes.

When all user-nodes are entered, conductive values must be calculated and entered for nodal connections. Except for some specialized situations, all conductance values must be pre-calculated by the user. The current version of ITAS will not automatically calculate the conductance between the nodes.

The preceding paragraphs represent the minimum required tasks to be completed in order to execute an ITAS run. Other options are available with the problem dictating option usage.

II. THERMAL MODEL

A. MATERIAL

In order to create the thermal model, the materials for all components and structures must be selected, as well as their geometry. Judicious selection of nodes must be made as well as the following thermal model material parameters determined. [Ref. 3: p. 435]

- Strength
- Stiffness.
- Density (weight)
- Thermal conductivity
- Thermal expansion
- Corrosion resistance
- Cost
- Fracture toughness
- Ease of fabrication
- Versatility of attachment options
- Availability

In addition to the above mentioned mechanical and thermal properties of spacecraft materials, there are other properties of note such as ductility, brittleness, creep, and fatigue strength.

Ductility measures the capacity of a material for inelastic deformation without rupture. Brittleness indicates little capacity for plastic deformation without failure. Ductility is measured by the percentage elongation of tensile test specimen after failure for a specified gauge length. Usually, a material having less than 5% elongation at fracture is said to be brittle and one having more is said to be ductile.

Creep is defined as the time-dependent deformation of a material under an applied load. It is usually regarded as an elevated temperature phenomenon, although some materials also creep at room temperature. The results of tests of materials under a constant load and temperature are usually plotted as strain versus time up to ruptures. The plotted curve exhibits three distinct regions. The first stage includes both elastic and plastic deformities. This stage shows a decreasing creep rate which is due to the strain hardening. The second stage shows a constant minimum creep rate caused by the annealing effect. In the third stage, a considerable reduction in the cross-sectional area occurs, resulting in an increase in stress and creep rate which eventually leads to fracture.

In a tensile test, the load is applied gradually to the failure. Such load condition is known as static condition. A spacecraft is subjected to both static and dynamic loads. In a dynamic load, the stresses are repeated a large number of times, the actual maximum stress is below the ultimate strength of the material and quite frequently even below the yield strength. Such failures are called fatigue failures.

A fatigue failure starts with a small crack. Once a crack has developed, the stress concentration effect becomes greater and the crack progresses more rapidly. As the stress area decreases in size, the stress increases in magnitude until the part fails suddenly. The failure is similar to brittle material fracture.

For ferrous materials, the strength under repeated stresses is often referred to as the endurance limit. Endurance limit stress is the stress that can be repeated an infinite number of times without causing the fracture of the material. Nonferrous materials, such as aluminum alloys, do not have an endurance limit, as they continue to weaken when the stress cycles are repeated. Hence the fatigue strength is the maximum stress that can be repeated for specified number of cycles without producing the failure of the unit.

Stress concentration may be caused by any discontinuity, such as holes, notches, and any abrupt changes in the cross section. Under steady loads, the effect of stress concentration is reduced due to the redistribution of the stresses in the region of the stress concentration, resulting from the plastic flow of the material when the maximum stress reaches the yield point. The effect

of the stress concentration on the brittle material, under a steady load, may be severe since very little plastic flow occurs. Under repeated loads, however, the endurance strength of even ductile material may be greatly reduced due to stress concentration. [Ref. 4: p. 244-248]

1. Material Selection

For structural and component housing designs, the engineer must consider optional materials, types of structures, and construction methods by performing trade studies to compare weight and cost. Most metals are very nearly homogeneous, having constant properties throughout their composition, and isotropic, having the same properties regardless of direction. Non-metals are usually formed with composites, or blends of more than one material. Composite materials can be homogeneous or isotropic, but not generally.

a. EPS Housing

By far the most commonly used metallic material for spacecraft structures and housings is aluminum, of which there are many types and tempers. Aluminum is lightweight, strong, and readily formable. Aluminum and its alloys, numbering in the hundreds, are available in all common commercial forms. The metal does not oxidize progressively because, when exposed to air, a hard, microscopic oxide coating forms on the surface that seals the metal from the environment. The tight chemical bond of oxide is the reason that aluminum is not found in nature; it exists only as a compound.

Aluminum-alloy sheet can be formed, drawn, stamped, or spun. Many wrought or cast aluminum alloys can be welded, brazed, or soldered, and aluminum surfaces readily accept a wide variety of finishes, both mechanical and chemical. Because of their high electrical conductivity, many aluminum alloys are used as electrical conductors. Aluminum reflects radiant energy throughout the entire spectrum, is non-sparking, and non-magnetic.

Commercially pure aluminum has a tensile strength of about 13,000 psi. Cold-working the metal approximately doubles its strength. For greater strength, aluminum is alloyed with other elements such as manganese, silicon, copper, magnesium, or zinc. Like pure aluminum, the alloys can also be strengthened by cold-working. Some alloys are further strengthened and

hardened by heat treatments At subzero temperatures, aluminum is stronger than at room temperature and is no less ductile. Most aluminum alloys lose strength at elevated temperatures, although some retain significant strength to 500 deg. F. [Ref. 5: p. 48]

For this thesis, Aluminum 6061-T6 was chosen for the EPS housing material. It is a wrought aluminum-alloy containing 61% aluminum, or alloy purity, designated by the third and fourth digits, with a combination of magnesium and silicon as the major alloying elements. The T6 suffix in the designation number indicates that the alloy was solution-heat-treated and artificially aged.

b. Printed Circuit Boards

The printed circuit boards consist of six-layers with alternating levels of copper as the conductor and polyimide as the insulator, as shown in Appendix A. The copper is exposed on the bottom of the printed circuit board and the polyimide is exposed on the top of the circuit board. The top layer of polyimide is 'scratched' to allow for the uppermost layer of copper to be utilized as the signal layer for the components placed on the circuit board. The ground-layer of copper is the fourth layer from the top with the bottom layer of copper acting as the thermal plane.

Copper and copper alloys are fabricated in rod, plate, strip, sheet, tube shapes, forgings, wire, and castings. These alloys are grouped according to composition into several general categories: coppers, high-copper alloys, brasses, leaded brasses, bronzes, aluminum bronzes, silicon bronzes, copper nickels, and nickel silvers. Copper and its alloys form adherent films that are relatively impervious to corrosion and that protect the base metal from further attack. The copper alloys are used where any of the following properties are needed: good thermal or electrical conductivity, corrosion-resistance, ease of forming, ease of joining, and color. On a volume basis, copper has the highest conductivity of any commercial metal. On the other hand, copper and its alloys have relatively low strength-to-weight ratios and low strengths at elevated temperatures. Some alloys are susceptible to stress-corrosion cracking unless they are stress relieved. Copper and its alloys can be hot or cold-worked, although they work-harden. Ductility can be restored by annealing or in heating incident to welding or brazing operations. For our printed circuit board application as well as any application requiring maximum thermal or

electrical conductivity, the most widely used copper is C11000, known as "tough pitch" which contains approximately .03% oxygen and a minimum of 99.9% copper. [Ref. 5: p. 52]

As already stated, polyimide was utilized for printed circuit board fabrication. Polyimides are a family of some of the most heat and fire-resistant polymers known. Their excellent retention of mechanical and physical properties at high temperatures is due to the nature of the aromatic raw materials that are building blocks of polyimides.

Polyimides are formulated as both thermosets, and thermoplastics. Moldings and laminates are generally based on thermoset resins, although some are made from thermoplastic grades. Unlike most plastics, polyimides are available as laminates and shapes, molded parts, and stock shapes. Thin-film products such as enamel, adhesives, and coatings are usually derived from thermoplastic polyimide resins.

Laminates are based on continuous reinforcements including woven glass and quartz fabrics, or fibers of graphite, boron, quartz, or organic materials. Molding compounds contain discrete fibers such as chopped glass or asbestos, or particulate fillers such as graphite powder, MoS2, or PTFE.

Polyimide laminates can operate continuously in air at 500 °F; service temperature for intermittent exposure can range from cryogenic to as high as 900 °F. Glass-fiber-reinforced versions retain over 70% of their flexural strength and modulus at 480°F. Creep is almost nonexistent, even at high temperatures, and deformation under load (4,000 psi) is less than .05% at room temperature for 24 hours. These materials have good wear resistance and low coefficients of friction, both of which are further improved by PTFE fillers. Electrical properties of polyimide laminates are outstanding over a wide range of temperature and humidity conditions. [Ref. 5: p. 115]

B. GEOMETRY

1. EPS Housing

The EPS housing encases the Electrical Power System and is located on the -Y side of the upper equipment plate. The EPS will have a maximum mass of 5 lbm. the EPS must remain statically and dynamically within the mounting envelope. Thus, the thickness of the EPS walls must be calculated so as to meet these design criteria. Mounting of the EPS to the upper equipment plate will be by means of stainless steel screws into the upper equipment plate. The EPS housing is to have a mounting surface which is to contact the lower side of the equipment plate with a required flatness to within .002 in. over its length and width. The actual dimensions of the EPS, as well as the EPS housing location within PANSAT, are shown in Appendix B.

The EPS housing is thermally modeled in the ITAS system as a 6-sided box with the dimensions of 9 in. in the X-direction, 8 in. in the Y-direction, and 1.569 in. in the Z-direction. For more precise mathematical construction, the +Y and -Y sides of the EPS housing were divided into four distinct physical and mathematical nodes. This geometry is shown in Figure 2.

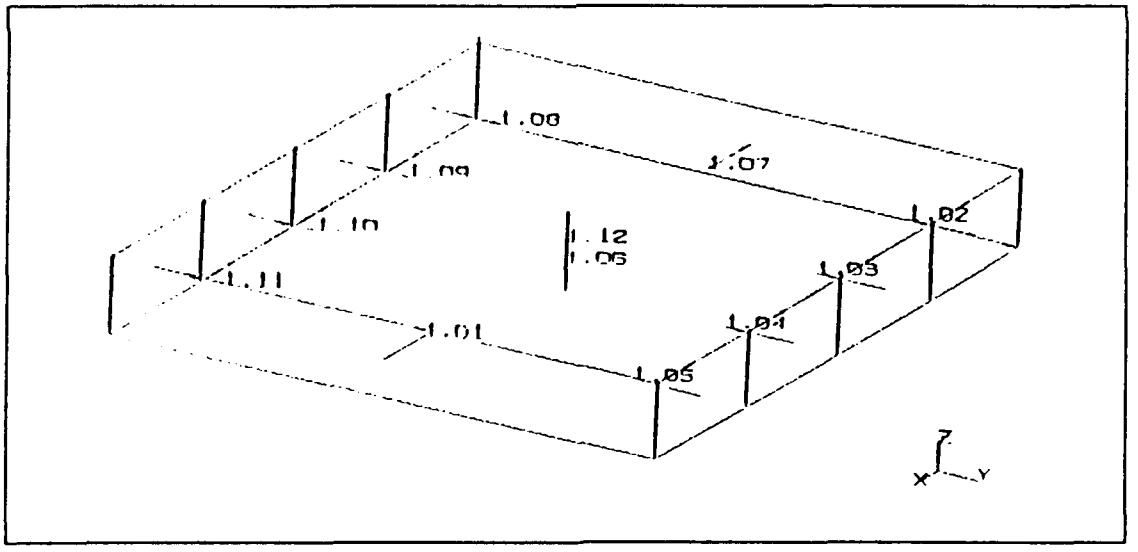


Figure 2. EPS Housing and Nodes

As can be seen in the figure, this results in the EPS housing having 12 physical nodes. It should be noted that these 12 nodes represent the inside-surfaces of the EPS housing since this thesis is concerned only with the inward-viewing geometry. Outside surface nodes would be

required if it were necessary to calculate the radiant thermal flux from other spacecraft components.

2. Printed Circuit Boards

There were several questions to address in the modeling of the printed circuit boards. The first question was whether or not to model the two circuit boards within the EPS as one-sided or two-sided for purposes of ITAS calculated view factors. The second question dealt with the determination of the number of physical nodes each circuit board would require for precise measurements. Once the number of nodes were determined, in what shapes would these nodes be? Lastly, once the overall thickness of the circuit boards was determined, how would each layer of a circuit board be modeled in relation to the other layers of the same board?

It was determined that for the most accurate measurements, the circuit boards would be modeled as 2-sided for view-factor and shadow-factor computations. After examination of both the upper and lower circuit board layouts and the power dissipation for each component on each board, a physical breakdown into nodes was completed. The printed circuit board layouts, power dissipation requirements, and nodal breakdowns for both boards can be found in Appendix A. The upper circuit board was modeled as two separate polygons with a total number of 18 physical nodes while the lower board was modeled as a single polygon and divided into 12 physical nodes. Nodal breakdowns for both boards was based on attempting to maximize the number of nodes for the sake of accuracy, while striving to minimize the number of nodes for sake of convenience and ease of calculation. These two somewhat contradictory approaches yielded the results shown. For both circuit boards, all physical nodes were rectangular, a construct which greatly reduces the number of user calculations.

The overall thickness of both circuit boards was determined to be .062 in. The copper layers were of the 1 ounce type which means that the thickness would be that of 1 ounce of copper over a 1 sq. ft. area. Using the density of copper at 20 °C, yielding 8.96 g/cm^3, and converting to oz/ft^3 resulted in a density of 8,949 oz/ft^3. Solving for the volume, and thus the thickness:

$$t = \frac{M}{DLW} = \frac{1oz}{(8949oz / ft^3)(1ft)(1ft)} = .00011ft$$

t = .00134 in.

This is the thickness for one layer of the copper. Multiplying by 3 yielded the thickness for all copper layers. Subtracting this from .062 and dividing that number by 3 yielded a thickness for each polyimide layer of .01933 in. These thicknesses will be used later in calculation of flux areas for thermal conductivity between nodes.

For the modeling of the circuit board layers, each layer was given the identical geometry. For the top printed circuit board, the bottom layer of thermal plane copper was numbered from 601 to 618 with next layer up being a polyimide layer with node numbers of 501 to 518. This numbering system was continued with each subsequently higher layer numbering in the 400's, 300's, 200's, and 100's. This same numbering technique was used in the bottom board as well with the layers numbered from the 1600's to 1100.

C. THERMAL NODES

1. Node Definitions

Appendix C contains a listing of all ITAS generated surface numbers and the user-generated node numbers that were assigned to them. These user node assignments are made in order to create a mathematical node for each surface for thermal calculations. All EPS housing thermal nodes were given 900 series numbers, from 901 to 912. Node no. -913 was input as the thermal node for the bottom of the upper equipment plate. Thus, the EPS housing-PANSAT thermal interface will be between the 906 and -913 nodes. Recall that the minus sign in front of 913 indicates that particular node will have a constant temperature.

In addition to the physical nodes that were created geometrically in ITAS, several more mathematical nodes were created in order to more effectively model the overall system. The inside geometry of the model can be seen in Appendix D. What this will show is a simple line schematic of a box with two flat (thin) surfaces representing the printed circuit boards. This model is constructed this way, as mentioned earlier, to calculated the view and shadow factors internal to

the EPS. However, the actual physical contact between the printed circuit boards and the housing occurs along ledges that the printed circuit boards rest upon along the +Y and -Y sides of the housing. In addition to these ledges, there are mechanical devices which, when screwed down, wedge against the top of the printed circuit boards and the housing overhang to secure the printed circuit board. These rails were assigned node numbers as follows:

- +Y bottom rail: 921
- +Y middle rail: 922
- +Y top rail: 923
- -Y bottom rail: 924
- -Y middle rail: 925
- -Y top rail: 926

These nodes will provide a means of calculating the conductance from the bottom portion of both PCB's copper thermal planes to the EPS housing. There will also be some conductance from the top layer of polyimide on both PCB's to the railing nodes via the screw attachments wedged against the top of the board, though these values would be expected to be very small.

2. Node Conductance Calculations

There were 8 different node calculation variations: Housing to housing; housing to PANSAT upper-equipment plate; railing to housing; PCB copper thermal-layer to railing; PCB top polyimide-layer to railing; PCB copper-layer; PCB polyimide-layer; PCB copper-layer to polyimide-layer. For the purposes of calculations, thermal nodes are physically located in the 3-dimensional center of each physical surface. A general description of each calculation variation is included below, and a listing of ITAS conductance entries is included as Appendix E.

Recall that the general formula for the calculation of conductivity between two nodes in a solid medium is:

$$K = \frac{kA}{L}$$

The general method for calculating the conductance between 2 nodes where 2 surfaces are in contact is as follows: First, calculate the conductance from 1 node to the surface interface

This is calculated using equation (5). Repeat this for the second node to surface interface, then calculate the contact conductance for the two surfaces as discussed in the background section. Once these 3 conductance's are calculated, solve the following equation for the overall conductance between the 2 nodes:

$$K_o = \frac{1}{\frac{1}{K_1} + \frac{1}{h_c} + \frac{1}{K_2}} \qquad (9)$$

a. Housing to Housing Node Calculations [Ref. Table 1]

Conductances were calculated using equation (5) and the following thermal conductivity of aluminum:

$$k = 170\frac{W}{m^\circ C} = 4.31\frac{W}{in^\circ C}$$

b. EPS Housing to PANSAT Upper Equipment Plate

To calculate the conductance through the equipment plate, it was assumed that the equipment plate thickness was .125 in. yielding a value for L of .0625. With a total area of contact of 72 in.^{2}. Using the same thermal conductivity of k as from part a., we obtain K_1 = 4965 W/°C.

To calculate the conductance through the top of the EPS housing, A = 72 in^2 and L = .0995 in. were used, yielding K_2 = 3118.79 W/°C. To solve for the contact conductance, the following parameters were assumed: P = 10 psi; H = 1180 x 10^6 n/m^2; S_r = 7 microm. These values yielded h_c = 134.136 W/°C. Now, solving for K_o:

$$K_o = 125 \text{ W/°C}$$

c. Railing to Housing Conductances [Ref. Table 2]

Although the railing nodes are mathematically distinct from the housing nodes, the physical reality is that the railings are not separate from those walls. Thus, the conductance calculations do not include contact conductances.

TABLE 1. HOUSING TO HOUSING NODE CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	LENGTH (in)	K (W/°C)
901	905	0.3138	5.1250	0.2638
901	906	1.5440	5.2845	1.2592
901	911	0.3138	5.1250	0.2638
901	912	1.5440	5.2845	1.2592
902	903	0.3138	2.2500	0.6011
902	906	0.4342	4.7845	0.3911
902	907	0.3138	5.1250	0.2638
902	912	0.4342	4.7845	0.3911
903	904	0.3138	2.2500	0.6011
903	906	0.4342	4.7845	0.3911
903	912	0.4342	4.7845	0.3911
904	905	0.3138	2.2500	0.6011
904	906	0.4342	4.7845	0.3911
904	912	0.4342	4.7845	0.3911
905	906	0.4342	4.7845	0.3911
905	912	0.4342	4.7845	0.3911
908	906	0.4342	4.7845	0.3911
908	909	0.3138	2.2500	0.6011
908	912	0.4342	4.7845	0.3911
909	906	0.4342	4.7845	0.3911
909	910	0.3138	2.2500	0.6011
909	912	0.4342	4.7845	0.3911
910	906	0.4342	4.7845	0.3911
910	911	0.3138	2.2500	0.6011
910	912	0.4342	4.7845	0.3911
911	906	0.4342	4.7845	0.3911
911	912	0.4342	4.7845	0.3911

TABLE 2. RAILING TO HOUSING NODE CONDUCTANCES

From Node	To Node	Area (in^2)	Length (in)	K (W/°C)
921	901	0.0625	4.6000	0.0585
921	902	0.0625	4.6000	0.0585
921	903	0.5625	0.2250	10.7750
921	904	0.5625	0.2250	10.7750
921	905	0.5625	0.2250	10.7750
921	906	0.5625	0.2250	10.7750

921	912	2.2500	0.2440	39.7438
922	901	0.1720	4.6000	0.1611
922	902	0.1720	4.6000	0.1611
922	903	1.5480	0.2250	29.6528
922	904	1.5480	0.2250	29.6528
922	905	1.5480	0.2250	29.6528
922	906	1.5480	0.2250	29.6528
923	901	0.1252	4.6000	0.1173
923	907	0.1252	4.6000	0.1173
923	902	1.1272	0.2250	21.5921
923	903	1.1272	0.2250	21.5921
923	904	1.1272	0.2250	21.5921
923	905	1.1272	0.2250	21.5921
923	906	2.2500	0.3470	27.9466
924	901	0.0625	4.6000	0.0585
924	907	0.0625	4.6000	0.0585
924	908	0.5625	0.2250	10.7750
924	909	0.5625	0.2250	10.7750
924	910	0.5625	0.2250	10.7750
924	911	0.5625	0.2250	10.7750
924	912	2.2500	0.2440	39.7438
925	901	0.1720	4.6000	0.1611
925	907	0.1720	4.6000	0.1611
925	908	1.5480	0.2250	29.6528
925	909	1.5480	0.2250	29.6528
925	910	1.5480	0.2250	29.6528
925	911	1.5480	0.2250	29.6528
926	901	0.1252	4.6000	0.1173
926	907	0.1252	4.6000	0.1173
926	908	1.1272	0.2250	21.5921
926	909	1.1272	0.2250	21.5921
926	910	1.1272	0.2250	21.5921
926	911	1.1272	0.2250	21.5921
926	906	2.2500	0.3470	27.9466

d. PCB Copper to Railing Conductances

(1) Top PCB Thermal Plane Copper to Railing. Assumptions:

P = 10 psi

S_r (both) = 7 microm

$H_{al} = 1180 \times 10^6$ n/m^2

L_{cu} = .00067 in.
L_{rail} = .344 in.
k_{cu} = 9.65 W/in°C
k_{al} = 4.31 W/in°C

Thus: h_c = 2.574 W/in^2°C

TABLE 3. TOP PCB THERMAL PLANE COPPER TO RAILING COPPER TO RAILING CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	h_c	K_1(Cu)	K_2(A1)	K_o
601	925	0.3750	0.9652	5,401	4.6984	0.8007
602	925	0.6000	1.5444	8,641	7.5174	1.2811
603	925	0.6062	1.5604	8,731	7.5957	1.2945
604	925	0.9187	2.3648	13,232	11.5110	1.9620
614	922	0.1875	0.4826	2,700	2.3490	0.4003
615	922	0.2500	0.6435	3,600	3.1320	0.5338
616	922	0.3437	0.8848	4,951	4.3068	0.7340
617	922	0.6550	1.6859	9,433	8.2065	1.3986
618	922	0.8125	2.0913	11,702	10.1798	1.7351

(2) Bottom PCB Thermal Plane Copper to Railing. Assumptions are the same as in (1), above.

TABLE 4. BOTTOM PCB THERMAL PLANE COPPER TO RAILING CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	hc	K_1(Cu)	K_2(A1)	Ko
1601	924	0.6250	1.6087	9,007	21.5500	1.4967
1602	924	0.7187	1.8500	10,352	24.7825	1.7123
1603	924	0.5625	1.4478	8,101	19.3950	1.3470
1604	924	0.3437	0.8848	4,951	11.8525	0.8232
1609	921	0.6250	1.6087	9,001	21.5500	1.4967
1610	921	0.7187	1.8500	10,352	24.7825	1.7213
1611	921	0.5625	1.4478	8,101	19.3950	1.3470
1612	921	0.3437	0.8848	4,951	11.8525	0.8232

e. PCB Polyimide to Railing Conductances

(1) Top PCB. Assumptions:
P = 10 psi
S_r (both) = 7 microm

$H_{poly} = 1537 \times 10^6$ N/m^2
$L_{rail} = .344$ in.
$L_{poly} = .00966$ in.
$k_{poly} = .2$ W/m°C

Thus, $h_c = .004378$ W/in^{2o}C

TABLE 5. TOP PCB POLYIMIDE LAYER TO RAILING CONDUCTANCES

FROM NODE	TO NODE	AREA(in^2)	h_c	K_1(Poly)	K_2(Al)	K_0
101	926	0.3750	0.0016	0.1940	6.4520	0.0016
102	926	0.6000	0.0026	0.3100	10.3233	0.0026
103	926	0.6062	0.0026	0.3130	10.4308	0.0026
104	926	0.9187	0.0040	0.4750	15.8076	0.0039
114	923	0.1875	0.0008	0.0970	3.2260	0.0008
115	923	0.2500	0.0011	0.1290	4.3013	0.0010
116	923	0.3437	0.0015	0.1770	5.9144	0.0014
117	923	0.6550	0.0028	0.3390	11.2696	0.0028
118	923	0.8125	0.0035	0.4200	13.9775	0.0035

(2) Bottom PCB. Assumptions are the same as above.

TABLE 6. BOTTOM PCB POLYIMIDE LAYER TO RAILING CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	h_c	K_1(Poly)	K_2(Al)	K_0
1101	925	0.6250	0.0027	0.3234	7.8306	0.0027
1102	925	0.7187	0.0031	0.3720	9.0052	0.0031
1103	925	0.5625	0.0024	0.2911	7.0476	0.0024
1104	925	0.3437	0.0015	0.1779	4.3068	0.0014
1109	922	0.6285	0.0027	0.3234	7.8306	0.0027
1110	922	0.7187	0.0031	0.3720	9.0052	0.0031
1111	922	0.5625	0.0024	0.2911	7.0476	0.0024
1112	922	0.3437	0.0015	0.1779	4.3068	0.0014

f. PCB Copper-layer Conductances

(1) Top PCB.

TABLE 7. TOP PCB COPPER-LAYER CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	LENGTH (in)	K (W/°C)
601	602	0.0033	1.9500	0.0165
601	605	0.0020	2.6250	0.0073
602	603	0.0033	2.4125	0.0134
602	606	0.0033	2.6250	0.0118
603	604	0.0033	2.5500	0.0126
603	607	0.0032	2.6250	0.0119
604	608	0.0035	2.6250	0.0131
605	606	0.0036	1.9500	0.0182
605	609	0.0010	2.0312	0.0030
605	610	0.0010	2.0312	0.0030
606	607	0.0036	2.4125	0.0148
606	610	0.0003	2.0312	0.0015
606	611	0.0018	2.0312	0.0087
606	612	0.0010	2.0312	0.0049
607	608	0.0036	2.5500	0.0139
607	612	0.0024	2.0312	0.0117
607	613	0.0007	2.0312	0.0036
608	613	0.0035	2.0312	0.0170
609	610	0.0017	0.8750	0.0194
609	614	0.0010	1.3750	0.0045
610	611	0.0017	1.1875	0.0143
610	615	0.0013	1.3750	0.0094
611	612	0.0017	2.0000	0.0085
611	616	0.0018	1.3750	0.0129
612	613	0.0017	2.9375	0.0057
612	617	0.0035	2.9375	0.0115
613	618	0.0043	1.3750	0.0305
614	615	0.0019	0.8750	0.0212
615	616	0.0019	1.1875	0.0182
616	617	0.0019	2.0000	0.0108
617	618	0.0019	1.3750	0.0157

These conductances were utilized for all three copper layers of the top printed circuit board.

(2) Bottom PCB.

TABLE 8. BOTTOM PCB COPPER-LAYER CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	LENGTH (in)	K (W/°C)
1601	1602	0.0033	2.3750	0.0136
1601	1604	0.0046	2.6875	0.0168
1602	1603	0.0033	2.2500	0.0143
1602	1605	0.0016	2.6875	0.0060
1603	1606	0.0043	2.6875	0.0156
1604	1605	0.0038	2.3750	0.0156
1604	1607	0.0046	2.5625	0.0176
1605	1606	0.0038	2.2500	0.0165
1605	1608	0.0016	2.5625	0.0063
1606	1609	0.0043	2.5625	0.0164
1607	16u8	0.0030	2.3750	0.0122
1607	1610	0.0046	1.8125	0.0249
1608	1609	0.0030	2.2500	0.0129
1608	1611	0.0016	1.8125	0.0089
1609	1612	0.0043	1.8125	0.0231
1610	1611	0.0018	2.3750	0.0074
1611	1612	0.0018	2.2500	0.0079

These conductances were utilized for all three copper-layers of the bottom printed circuit board.

g. PCB Polyimide-layer Conductances

(1) Top PCB.

TABLE 9. TOP PCB POLYIMIDE-LAYER CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	LENGTH (in)	K (W/°C)
501	502	0.0483	1.9500	0.00012
501	505	0.0289	2.6250	0.00005
502	503	0.0483	2.4125	0.00010
502	506	0.0463	2.6250	0.00008
503	504	0.0483	2.5500	0.00009
503	507	0.0468	2.6250	0.00009
504	508	0.0517	2.6250	0.00009
505	506	0.0531	1.9500	0.00013
505	509	0.0145	2.0312	0.00003
505	510	0.0145	2.0312	0.00003

506	507	0.0531	2.4125	0.00011
506	510	0.0048	2.0312	0.00001
506	511	0.0265	2.0312	0.00006
506	512	0.0149	2.0312	0.00003
507	508	0.0531	2.5500	0.00010
507	512	0.0357	2.0312	0.00008
507	513	0.0111	2.0312	0.00002
508	513	0.0517	2.0312	0.00012
509	510	0.0253	0.8750	0.00014
509	514	0.0144	1.3750	0.00005
510	511	0.0253	1.1875	0.00010
510	515	0.0193	1.3750	0.00007
511	512	0.0253	2.0000	0.00006
511	516	0.0265	1.3750	0.00009
512	513	0.0253	2.9375	0.00004
512	517	0.0507	2.9375	0.00008
513	518	0.0628	1.3750	0.00023
514	515	0.0277	0.8750	0.00016
515	516	0.0277	1.1875	0.00011
516	517	0.0277	2.0000	0.00007
517	518	0.0277	1.3750	0.00010

These conductances were utilized for all three polyimide-layers of the top printed circuit board.

(2) Bottom PCB.

TABLE 10. BOTTOM PCB POLYIMIDE-LAYER CONDUCTANCES

FROM NODE	TO NODE	AREA (in^2)	LENGTH (in)	K (W/°C)
1101	1102	0.0483	2.3750	0.00010
1101	1104	0.0676	2.6875	0.00012
1102	1103	0.0483	2.2500	0.00010
1102	1105	0.0241	2.6875	0.00004
1103	1106	0.0628	2.6875	0.00011
1104	1105	0.0676	2.5625	0.00013
1104	1107	0.0555	2.3750	0.00011
1105	1106	0.0555	2.2500	0.00012
1105	1108	0.0241	2.5625	0.00004

1106	1109	0.0628	2.5625	0.00012
1107	1108	0.0676	1.8125	0.00018
1107	1110	0.0434	2.3750	0.00009
1108	1109	0.0434	2.2500	0.00009
1108	1111	0.0241	1.8125	0.00006
1109	1112	0.0628	1.8125	0.00017
1110	1111	0.0265	2.3750	0.00005
1111	1112	0.0265	2.2500	0.00005

These conductance's were utilized for all three polyimide-layers of the bottom printed circuit board.

h. PCB Copper-layer to Polyimide-layer Conductances

(1) Top PCB. Assumptions are as follows:

P = 10 psi
H_{poly} = 1537 x 10^6 N/m^2
S_r = 7 microm.
L_{cu} = .00067 in.
L_{poly} = .00966 in.
k_{cu} = 4.31 W/in°C
k_{poly} = .2 W/in°C

Yields: h^c = .0034 W/in^{2o}C

These conductances are listed in Table 11 and were utilized for all copper-layer to polyimide-layer conductance relationships for the top PCB.

TABLE 11. TOP PCB COPPER-LAYER TO POLYIMIDE-LAYER CONDUCTANCES

FROM NODE	TO NODE	AREA(in^2)	h_c	K_1(Cu)	K_2(A1)	K_o
601	501	3.7500	0.0127	54,011	1.9400	0.0126
602	502	6.0000	0.0204	86,417	3.1000	0.0202
603	503	6.0620	0.0206	87,310	3.1370	0.0204
604	504	6.6780	0.0227	96,312	3.4610	0.0225
605	505	4.1250	0.0140	59,412	2.1350	0.0139
606	506	6.6000	0.0224	95,059	3.4160	0.0222
607	507	6.6680	0.0226	96,039	3.4510	0.0225
608	508	7.3560	0.0250	105,948	3.8070	0.0071
609	509	0.9840	0.0033	14,172	0.5090	0.0033
610	510	1.3125	0.0044	18,903	0.6790	0.0044

611	511	1.8040	0.0061	25,982	0.9330	0.0060
612	512	3.4780	0.0118	50,093	1.8000	0.0117
613	513	4.2650	0.0145	61,428	2.2070	0.0144
614	514	1.0780	0.0036	15,526	0.5570	0.0036
615	515	1.4375	0.0048	20,704	0.7440	0.0048
616	516	1.9760	0.0067	28,460	1.0220	0.0066
617	517	3.8090	0.0129	54,860	1.9710	0.0128
618	518	1.8040	0.0061	25,982	0.9330	0.0060

(2) Bottom PCB. Assumptions made were the same as above in (1).

TABLE 12. BOTTOM PCB COPPER-LAYER TO POLYIMIDE-LAYER CONDUCTANCES

From node	To Node	Area (in^2)	h_c	K_1(Cu)	K_2(A1)	K_0
1601	1501	8.7500	0.0297	126,026	4.5200	0.0295
1602	1502	3.1250	0.0106	45,009	1.6174	0.0105
1603	1503	8.1250	0.0276	117,024	4.2054	0.0274
1604	1504	10.0625	0.0342	144,930	5.2083	0.0339
1605	1505	3.5937	0.0122	51,760	1.8601	0.0121
1606	1506	9.3437	0.0317	134,577	4.8363	0.0315
1607	1507	7.8750	0.0267	113,423	4.0760	0.0266
1608	1508	2.8125	0.0095	40,508	1.4559	0.0095
1609	1509	7.3125	0.0248	105,321	3.7849	0.0247
1610	1510	4.8125	0.0163	69,314	2.4909	0.0162
1611	1511	1.7187	0.0058	24,755	0.8896	0.0058
1612	1512	4.4687	0.0151	64,363	2.3130	0.0150

These conductances were utilized for all copper-layer to polyimide-layer conductance relationships for the bottom printed circuit board.

D. THERMAL MODEL PARAMETERS

1. Boundary Conditions

The boundary conditions for this steady-state thermal model involved both the temperature of the PANSAT upper-equipment plate and the amount of heat dissipated by printed circuit board electronic components. Boundary conditions were established for worst-case cold and worst-case hot conditions. For both cases, a starting temperature of 20°C was assigned to each surface node in the model.

a. Cold-Case

For the cold-case, the thermal node for the upper equipment plate, node number -913, was set equal to a constant 0°C. For power dissipation in the printed circuit boards, it was assumed that any component with less than a 100% duty cycle would be off. Further, the amount of heat dissipated would be for the eclipse period of the orbit.

b. Hot-Case

For the hot-case, the thermal node for the upper equipment plate, node number -913, was set equal to a constant 40°C. For power dissipation in the printed circuit boards, it was assumed that every component would be on, with the amount of heat dissipated being that for the sunlit portion of the orbit.

2. ITAS Inputs

a. Cold-Case

ITAS cold-case data entries and inputs are given in Appendix F.

b. Hot-Case

ITAS hot-case data entries and inputs are given in Appendix G. Note that the hot-case data entry Appendix G contains only the changes to the cold-case data entry Appendix F.

III. RESULTS AND ANALYSIS

A. ITAS OUTPUT

Actual running time for ITAS modeling for both the hot and cold cases was less than 2 minutes. By examining Appendices F and G it can be seen that ITAS first calculates the view-factor for each surface, then the radiated energy intercepted by that surface. Finally, the heat conduction for the model is calculated. Cold-case outputs can be found at the end of Appendix H. and hot-case outputs are located at the end of Appendix I.

B. ANALYSIS

1. Cold-Case

Examination of the ITAS calculated steady-state temperature for surfaces in the cold-case shows that temperatures range from a low of .12°C at the top of the EPS housing to a high of 20°C in the PCB's. This would seem to be a valid result since the largest possible heat transfer for this model should occur between nodes 906 and -913, the top of the EPS housing and the PANSAT upper equipment plate, respectively. With a constant temperature of 0°C for node -913, this node will act as a heat sink drawing heat away from the EPS housing due to the higher starting temperature of 20°C for the EPS surfaces and the heat being dissipated in the PCB's which will seek a conductive path to the heat sink. Since the conductive paths will allow only a finite amount of heat to be transferred in any given time, the relative temperatures of the surfaces illustrates a decreasing trend as a function of conductive path nearness to the upper-equipment plate. A complete listing of steady-state temperatures for each thermal node is given at the end of Appendix H, with a graphical representation of the temperature gradient utilizing selected nodes given in Figure 3. For both the cold-case and hot-case temperature gradient graphs, the paths selected represent worst-case paths for both the top and bottom printed circuit boards. This means that for the cold-case, starting at 0°C for node -913 to .12°C for node 906, the thermal path for the top and bottom printed circuit boards then diverge to different nodes with the top printed circuit board

thermal path proceeding to node 925 and the bottom printed circuit board thermal path proceeding to node 924. For the hot-case, the procedure is similar.

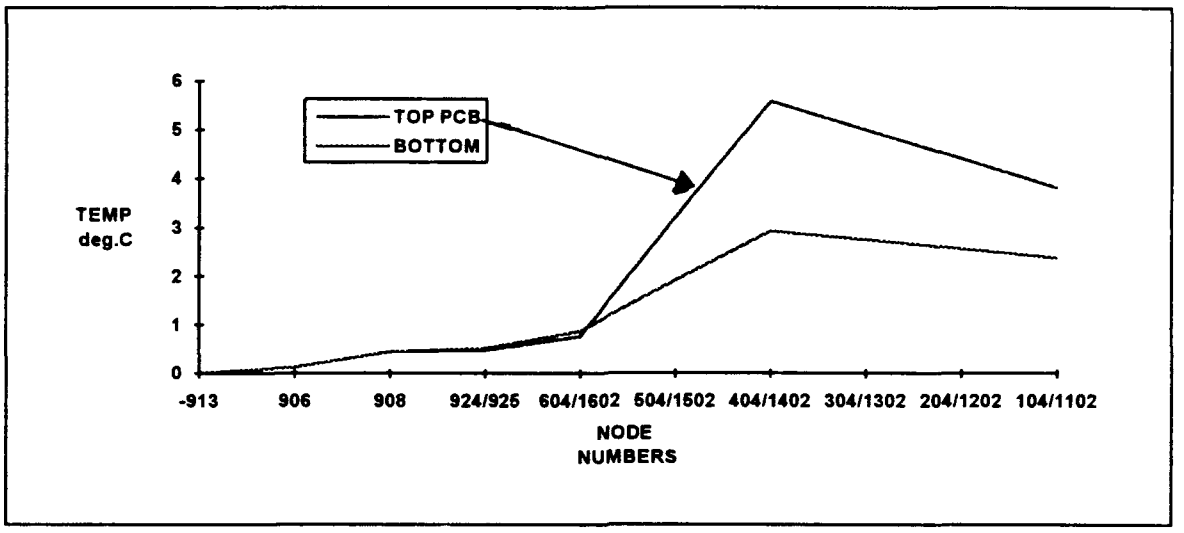


Figure 3. Cold-Case Temperature Gradient for Selected Nodes

2. Hot-Case

Examination of the ITAS calculated steady-state temperatures for surfaces in the hot case shows that temperatures range from a low of 20°C within the PCB's to a high of 39.91°C for the top of the EPS housing at node 906, the interface with the upper-equipment plate. The explanation for these results is similar to that described above for the cold-case, except that in the hot-case the upper-equipment plate is acting as a heat source for the EPS housing and PCB's. A complete listing of steady-state temperatures for each thermal node is given at the end of Appendix I, with a graphical representation of the temperature gradient utilizing selected nodes given in Figure 4.

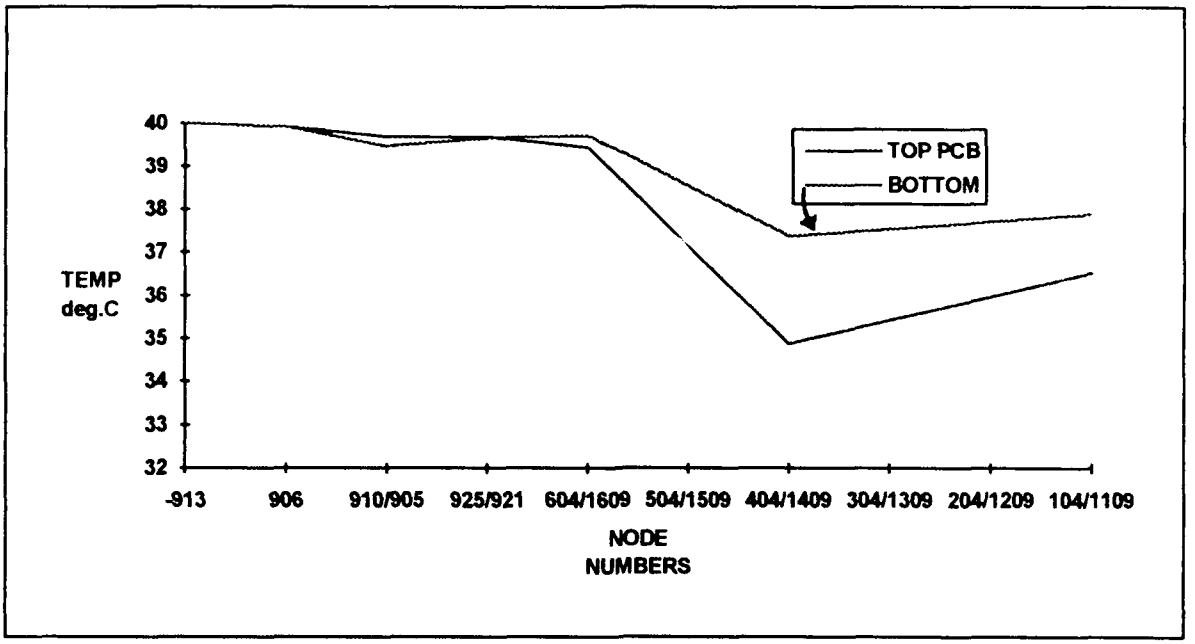


Figure 4. Hot-Case Temperature Gradient for Selected Nodes

C. CONCLUSIONS

It seems clear, given the results of this thermal model, that if only inward-viewing geometry and conductance relationships were taken into consideration that the thermal profile of the EPS housing and its associated electronic components on the PCB's would be at the mercy of the upper-equipment plate temperature. So large is the conductive path between the EPS housing and the upper equipment plate in comparison with all other conductive relationships, and given that the upper-equipment plate temperature is determined by the overall PANSAT temperature, it is critical that the normal on-orbit operating temperature limits of PANSAT be determined to within 10° of accuracy to preclude the possibility of electronic component failure. A reasonable first-order estimate of spacecraft temperature extremes can be obtained by the process given in Reference 3, page 425. If it proves to be too difficult to determine the temperature extremes to within the desired accuracy range, additional measures might be necessary to ensure EPS thermal integrity. Such measures might include the application of grease to the EPS-housing / upper-equipment plate interface, EPS specific heaters (mounted to the upper-equipment plate or the EPS housing itself),

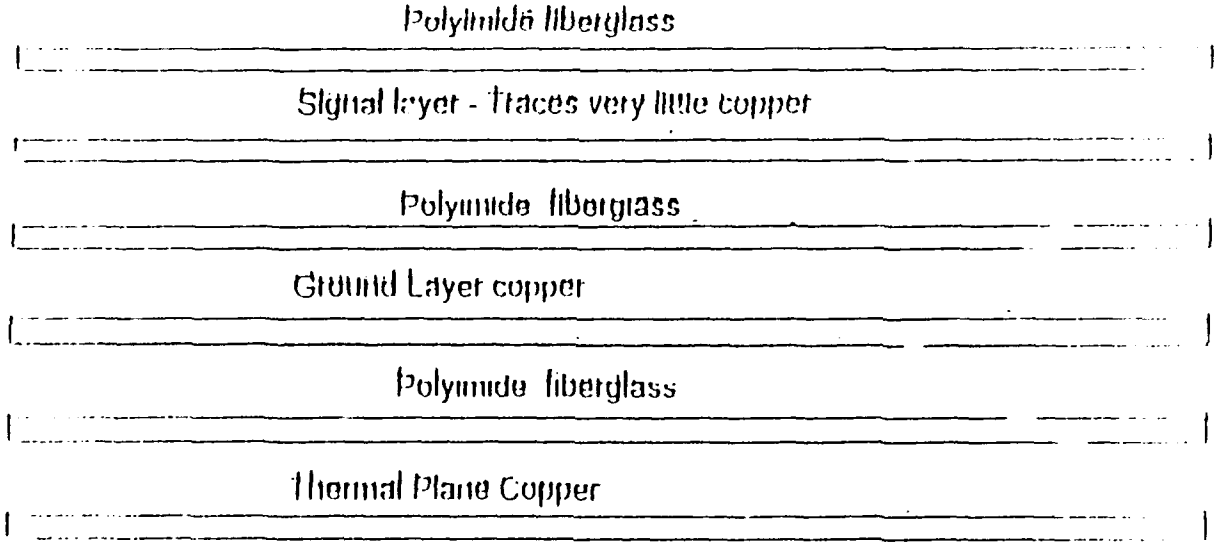
additional insulation for the housing, or an increase in the active control of the overall PANSAT thermal environment.

D. RECOMMENDATIONS

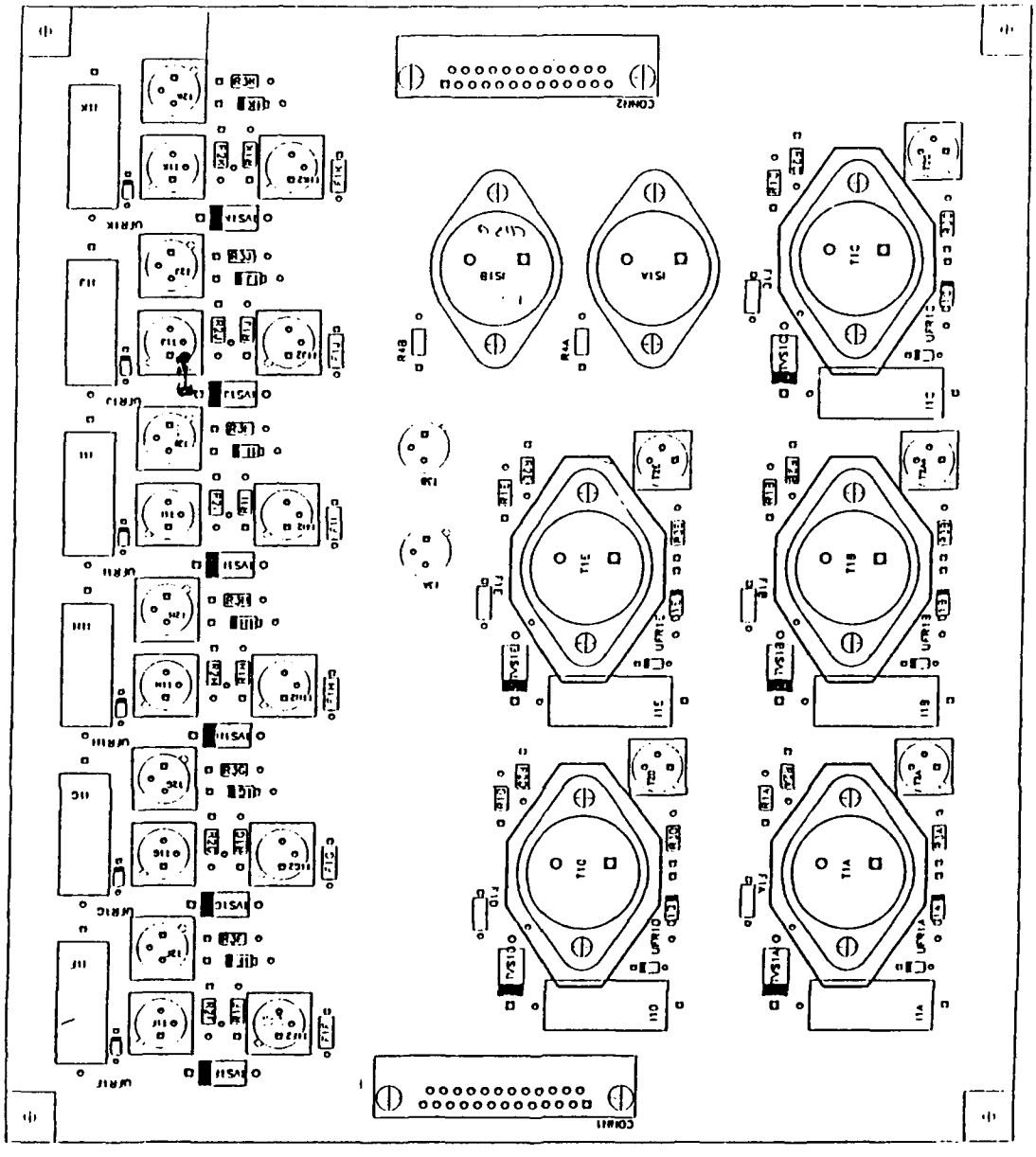
It is recommended that this thermal model be incorporated into the larger overall thermal model of the PANSAT. This could be accomplished most efficiently by utilizing this model as one of many modules with each module representing the major subsystems and components of the PANSAT. Further, it is desirable that a thermal test of the EPS system hardware be conducted in a vacuum chamber to test the closeness of the software modeling results to a "real-world" test of a physical system.

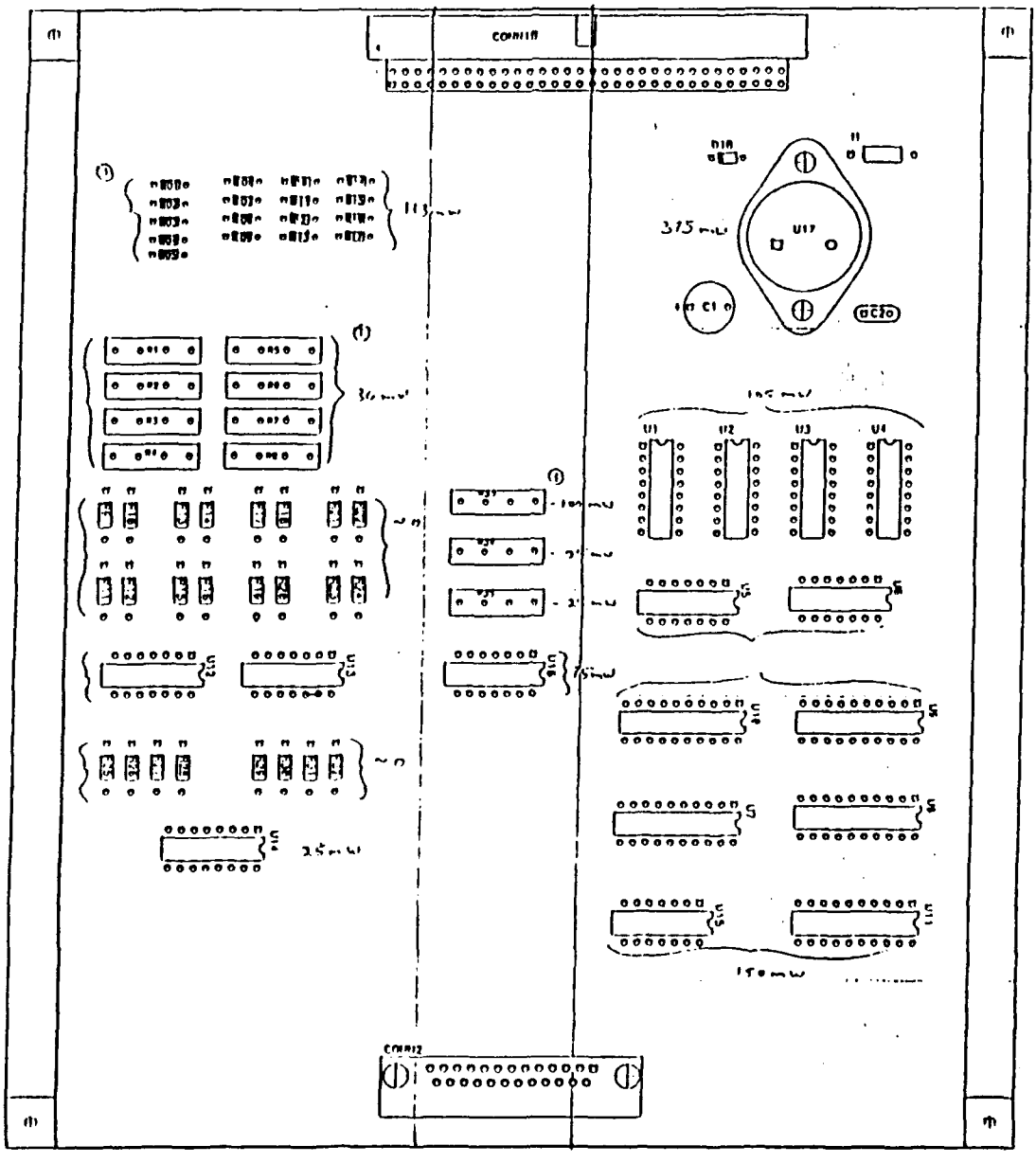
APPENDIX A

PCB Layer-Layer



PRINTED CIRCUIT BOARD LAYOUTS





① Power Dissipated circuit only in Socket Portion of PCB.

EPS Switch Board

Component	Designator	Subcircuit	Duty cycle	Power Dissipation, Bus = 15V (Sunlit)	Power Dissipation, Bus = 12V (Eclipse)	X-Coord	Y-Coord
Inductor	I1A	DCSA Power Switch	100	0.039	0.061	2.200	8.900
Transient Voltage Suppressor	TVS1A	"	~0			2.925	8.637
Ultra Fast Recovery Diode	UFR1A	"	~0			1.825	8.600
12v Zener Bi-Directional	D1A	"	~0			1.650	8.125
PMOSFET Gate Bias Resister	R1A	"	100	0.002	0.001	3.025	7.250
PMOSFET Gate Bias Resister	R2A	"	100	0.000	0.000	2.850	7.075
NMOSFET Gate Protection Resister	R3A	"	100	0.003	0.003	1.650	7.575
PMOSFET	T1A	"	100	0.006	0.009	2.375	7.850
NMOSFET	T2A	"	100	0.000	0.000	1.775	7.000
Pico Fuse	F1A	"				3.150	8.075
Inductor	I1B	DCSB Power Switch	100	0.039	0.061	2.200	6.475
Transient Voltage Suppressor	TVS1B	"	~0			2.925	6.212
Ultra Fast Recovery Diode	UFR1B	"	~0			1.825	6.175
12v Zener Bi-Directional	D1B	"	~0			1.650	5.700
PMOSFET Gate Bias Resister	R1B	"	100	0.002	0.001	3.025	4.825
PMOSFET Gate Bias Resister	R2B	"	100	0.000	0.000	2.850	4.650
NMOSFET Gate Protection Resister	R3B	"	100	0.003	0.003	1.650	5.150
PMOSFET	T1B	"	100	0.006	0.009	2.375	5.425
NMOSFET	T2B	"	100	0.000	0.000	1.775	4.575
Pico Fuse	F1B	"				3.150	5.650
Inductor	I1C	RF Power Switch - *Rx only*	70	0.010	0.015	2.200	4.050
Transient Voltage Suppressor	TVS1C	"	~0			2.925	3.787
Ultra Fast Recovery Diode	UFR1C	"	~0			1.825	3.750
12v Zener Bi-Directional	D1C	"	~0			1.650	3.275
PMOSFET Gate Bias Resister	R1C	"	100	0.002	0.001	3.025	2.400
PMOSFET Gate Bias Resister	R2C	"	100	0.000	0.000	2.850	2.225
NMOSFET Gate Protection Resister	R3C	"	70	0.003	0.003	1.650	2.725
PMOSFET	T1C	"	70	0.006	0.009	2.375	3.000
NMOSFET	T2C	"	70	0.000	0.000	1.775	2.150
Pico Fuse	F1C	"				3.150	3.225
Inductor	I1C	RF Power Switch - *Rx and Tx*	30	0.088	0.138		
Transient Voltage Suppressor	TVS1C	"	~0				
Ultra Fast Recovery Diode	UFR1C	"	~0				
12v Zener Bi-Directional	D1C	"	~0				
PMOSFET Gate Bias Resister	R1C	"	30	0.002	0.001		

EPS Switch Board

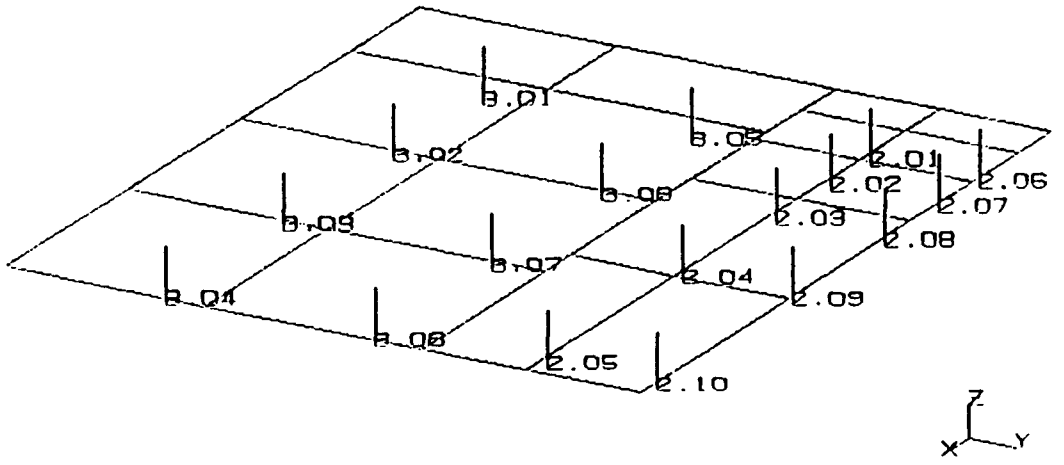
Component	Designator	Subcircuit	Duty cycle	Power Dissipation, Bus = 15V (Sunlit)	Power Dissipation, Bus = 12V (Eclipse)	X-Coord	Y-Coord
PMOSFET Gate Bias Resister	R2C	"	30	0.000	0.000		
NMOSFET Gate Protection Resister	R3C	"	30	0.003	0.003		
PMOSFET	T1C	"	30	0.014	0.021		
NMOSFET	T2C	"	30	0.000	0.000		
Pico Fuse	F1C	"					
Inductor	I1D	CHARG Battery A Power Switch	60	0.012	N/A	4.300	8.900
Transient Voltage Suppressor	TVS1D	"	~0		"	5.025	8.637
Ultra Fast Recovery Diode	UFR1D	"	~0		"	3.925	8.600
12v Zener Bi-Directional	D1D	"	~0		"	3.750	8.125
PMOSFET Gate Bias Resister	R1D	"	60	0.002	"	5.125	7.250
PMOSFET Gate Bias Resister	R2D	"	60	0.000	"	4.950	7.075
NMOSFET Gate Protection Resister	R3D	"	60	0.003	0.003	3.750	7.575
PMOSFET	T1D	"	60	0.008	"	4.475	7.850
NMOSFET	T2D	"	60	0.000	"	3.875	7.000
Pico Fuse	F1D	"			"	5.250	8.175
Inductor	I1E	CHARG Battery B Power Switch	60	0.050	N/A	4.300	6.475
Transient Voltage Suppressor	TVS1E	"	~0		"	5.025	6.212
Ultra Fast Recovery Diode	UFR1E	"	~0		"	3.925	6.175
12v Zener Bi-Directional	D1E	"	~0		"	3.750	5.700
PMOSFET Gate Bias Resister	R1E	"	60	0.002	"	5.125	4.825
PMOSFET Gate Bias Resister	R2E	"	60	0.000	"	4.950	4.650
NMOSFET Gate Protection Resister	R3E	"	60	0.003	0.003	3.750	5.150
PMOSFET	T1E	"	60	0.008	"	4.475	5.425
NMOSFET	T2E	"	60	0.000	"	3.875	4.575
Pico Fuse	F1E	"			"	5.250	5.650
Inductor	I1F	MUX A	30	0.006	0.009	8.400	8.875
Transient Voltage Suppressor	TVS1F	"	~0			7.297	9.450
Ultra Fast Recovery Diode	UFR1F	"	~0			8.125	9.225
12v Zener Bi-Directional	D1F	"	~0			7.175	8.550
PMOSFET Gate Bias Resister	R1F	"	30	0.002	0.001	7.175	8.950
PMOSFET Gate Bias Resister	R2F	"	30	0.000	0.000	7.400	8.950
NMOSFET Gate Protection Resister	R3F	"	30	0.003	0.003	7.225	8.375
PMOSFET	T1F	"	30	0.003	0.004	7.775	9.050
PMOSFET	T1F2	"	30	0.003	0.004	6.850	9.050
NMOSFET	T2F	"	30	0.000	0.000	7.775	8.450
Pico Fuse	F1F	"	100			6.475	9.125

EPS Switch Board

Component	Designator	Subcircuit	Duty cycle	Power Dissipation, Bus = 15V (Sunlit)	Power Dissipation, Bus = 12V (Eclipse)	X-Coord	Y-Coord
Inductor	I1G	MUX B	30	0.006	0.009	8.400	7.525
Transient Voltage Suppressor	TVS1G	"	~0			7.297	8.100
Ultra Fast Recovery Diode	UFR1G	"	~0			8.125	7.875
12v Zener Bi-Directional	D1G	"	~0			7.175	7.200
PMOSFET Gate Bias Resister	R1G	"	30	0.002	0.001	7.175	7.600
PMOSFET Gate Bias Resister	R2G	"	30	0.000	0.000	7.400	7.600
NMOSFET Gate Protection Resister	R3G	"	30	0.003	0.003	7.225	7.025
PMOSFET	T1G	"	30	0.003	0.004	7.775	7.700
PMOSFET	T1G2	"	30	0.003	0.004	6.850	7.700
NMOSFET	T2G	"	30	0.000	0.000	7.775	7.100
Pico Fuse	F1G	"	100			6.475	7.775
Inductor	I1H	MASS A	30	0.001	0.002	8.400	6.175
Transient Voltage Suppressor	TVS1H	"	~0			7.297	6.750
Ultra Fast Recovery Diode	UFR1H	"	~0			8.125	6.525
12v Zener Bi-Directional	D1H	"	~0			7.175	5.850
PMOSFET Gate Bias Resister	R1H	"	30	0.002	0.001	7.175	6.250
PMOSFET Gate Bias Resister	R2H	"	30	0.000	0.000	7.400	6.250
NMOSFET Gate Protection Resister	R3H	"	30	0.003	0.003	7.225	5.675
PMOSFET	T1H	"	30	0.001	0.001	7.775	6.350
PMOSFET	T1H2	"	30	0.001	0.001	6.850	6.350
NMOSFET	T2H	"	30	0.000	0.000	7.775	5.750
Pico Fuse	F1H	"	100			6.475	6.425
Inductor	I1I	MASS B	30	0.001	0.002	8.400	4.825
Transient Voltage Suppressor	TVS1I	"	~0			7.297	5.400
Ultra Fast Recovery Diode	UFR1I	"	~0			8.125	5.175
12v Zener Bi-Directional	D1I	"	~0			7.175	4.500
PMOSFET Gate Bias Resister	R1I	"	30	0.002	0.001	7.175	4.900
PMOSFET Gate Bias Resister	R2I	"	30	0.000	0.000	7.400	4.900
NMOSFET Gate Protection Resister	R3I	"	30	0.003	0.003	7.225	4.325
PMOSFET	T1I	"	30	0.001	0.001	7.775	5.000
PMOSFET	T1I2	"	30	0.001	0.001	6.850	5.000
NMOSFET	T2I	"	30	0.000	0.000	7.775	4.400
Pico Fuse	F1I	"	100			6.475	5.075
Inductor	I1J	TRICKLE A	~0			8.400	3.475
Transient Voltage Suppressor	TVS1J	"	~0			7.297	4.050

EPS Switch Board

Component	Designator	Subcircuit	Duty cycle	Power Dissipation, Bus = 15V (Sunlit)	Power Dissipation, Bus = 12V (Eclipse)	X-Coord	Y-Coord
Ultra Fast Recovery Diode	UFR1J	"	~0			8.125	3.825
12v Zener Bi-Directional	D1J	"	~0			7.175	3.150
PMOSFET Gate Bias Resister	R1J	"	~0			7.175	3.550
PMOSFET Gate Bias Resister	R2J	"	~0			7.400	3.550
NMOSFET Gate Protection Resister	R3J	"	~0			7.225	3.975
PMOSFET	T1J	"	~0			7.775	3.650
PMOSFET	T1J2	"	~0			6.850	3.650
NMOSFET	T2J	"	~0			7.775	3.050
Pico Fuse	F1J	"	~0			6.475	3.725
Inductor	I1K	TRICKLE B	~0			8.400	2.100
Transient Voltage Suppressor	TVS1K	"	~0			7.297	2.675
Ultra Fast Recovery Diode	UFR1K	"	~0			8.125	2.450
12v Zener Bi-Directional	D1K	"	~0			7.175	.775
PMOSFET Gate Bias Resister	R1K	"	~0			7.175	2.175
PMOSFET Gate Bias Resister	R2K	"	~0			7.400	2.175
NMOSFET Gate Bias Resister	R3K	"	~0			7.225	1.600
PMOSFET	T1K	"	~0			7.775	2.275
PMOSFET	T1K2	"	~0			6.850	2.275
NMOSFET	T2K	"	~0			7.775	1.675
Pico Fuse	F1K	"	~0			6.475	2.350
NMOSFET	T3A	Discharge Battery A				5.750	5.300
NMOSFET	T3B	Discharge Battery B				5.775	3.650
LM150	IS1A	Constant Current Source				3.975	3.092
LM150	IS1B	Constant Current Source				5.225	3.092
			Total Power	0.211W	0.238W		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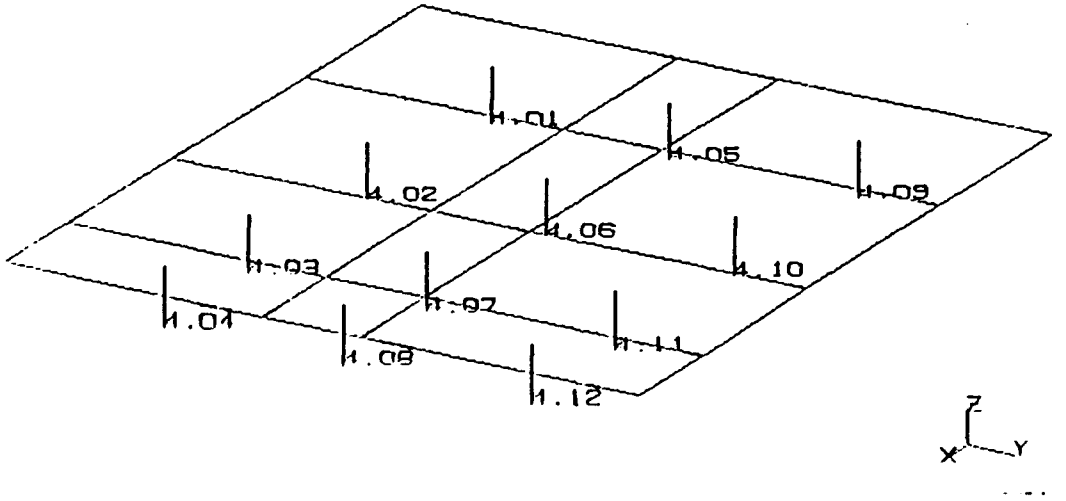
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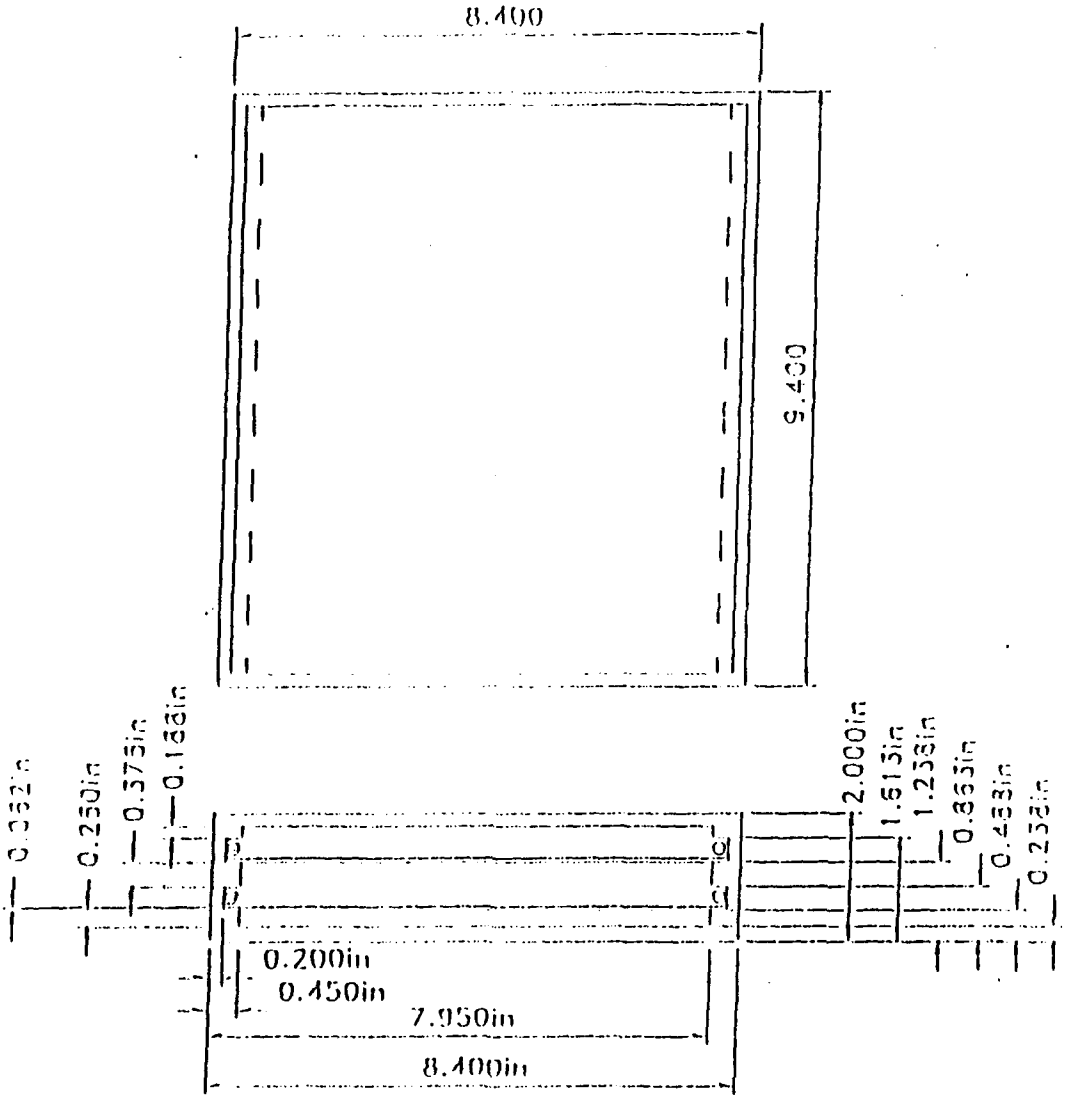
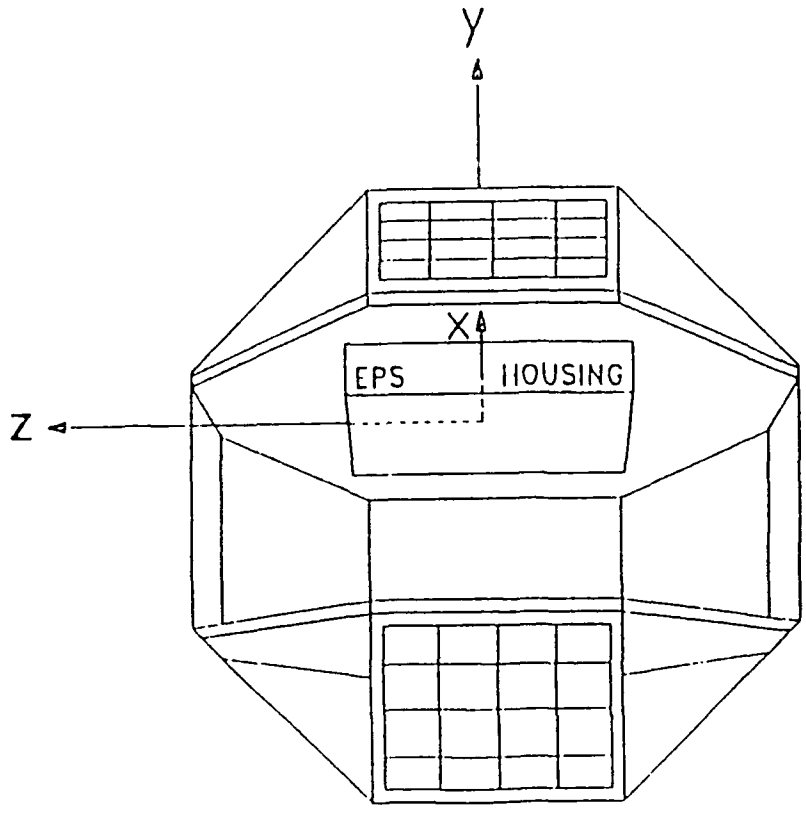
APPENDIX B

EPS HOUSING



EPS HOUSING LOCATION



APPENDIX C ITAS SURFACE-NODE NUMBERS

PgDn PgUp Home End F2Help

Ctrl : Copy (See F2) ITAS Property Data Entry

Seq	Surface No	NodeNo	Alpha	Emiss	T/Mass	Dissip	MID	Comments
1	1.01	1	.4	.8	1.	0.		EPS HOUSING
2	1.02	2	.4	.8	1.	0.		EPS HOUSING
3	1.03	3	.4	.8	1.	0.		EPS HOUSING
4	1.04	4	.4	.8	1.	0.		EPS HOUSING
5	1.05	5	.4	.8	1.	0.		EPS HOUSING
6	1.06	6	.4	.8	1.	0.		EPS HOUSING
7	1.07	7	.4	.8	1.	0.		EPS HOUSING
8	1.08	8	.4	.8	1.	0.		EPS HOUSING
9	1.09	9	.4	.8	1.	0.		EPS HOUSING
10	1.10	10	.4	.8	1.	0.		EPS HOUSING
11	1.11	11	.4	.8	1.	0.		EPS HOUSING
12	1.12	12	.4	.8	1.	0.		EPS HOUSING
13	2.01	13	0	.01	1.	0.		PCB 1-1
14	2.02	14	0	.01	1.	0.		PCB 1-1
15	2.03	15	0	.01	1.	0.		PCB 1-1
16	2.04	16	0	.01	1.	0.		PCB 1-1
17	2.05	17	0	.01	1.	0.		PCB 1-1
18	2.06	18	0	.01	1.	0.		PCB 1-1

S-F1Load/Save All S-F4Auto TM UDC Allowed ESCQuit

F1Load/Save Page F3PropLib F4AutoGen F5ImportPropFmt F6NewPropFile F10Search

PgDn PgUp Home End F2Help

Ctrl : Copy (See F2) ITAS Property Data Entry

Seq	Surface No	NodeNo	Alpha	Emiss	T/Mass	Dissip	MID	Comments
19	2.07	19	0	.01	1.	0.		PCB 1-1
20	2.08	20	0	.01	1.	0.		PCB 1-1
21	2.09	21	0	.01	1.	0.		PCB 1-1
22	2.10	22	0	.01	1.	0.		PCB 1-1
23	3.01	23	0	.01	1.	0.		PCB 1-2
24	3.02	24	0	.01	1.	0.		PCB 1-2
25	3.03	25	0	.01	1.	0.		PCB 1-2
26	3.04	26	0	.01	1.	0.		PCB 1-2
27	3.05	27	0	.01	1.	0.		PCB 1-2
28	3.06	28	0	.01	1.	0.		PCB 1-2
29	3.07	29	0	.01	1.	0.		PCB 1-2
30	3.08	30	0	.01	1.	0.		PCB 1-2
31	4.01	31	0	.01	1.	0.		PCB 2 (BOTTOM)
32	4.02	32	0	.01	1.	0.		PCB 2 (BOTTOM)
33	4.03	33	0	.01	1.	0.		PCB 2 (BOTTOM)
34	4.04	34	0	.01	1.	0.		PCB 2 (BOTTOM)
35	4.05	35	0	.01	1.	0.		PCB 2 (BOTTOM)
36	4.06	36	0	.01	1.	0.		PCB 2 (BOTTOM)

S-F1Load/Save All S-F4Auto TM UDC Allowed ESCQuit

F1Load/Save Page F3PropLib F4AutoGen F5ImportPropFmt F6NewPropFile F10Search

PgDn PgUp Home End F2Help

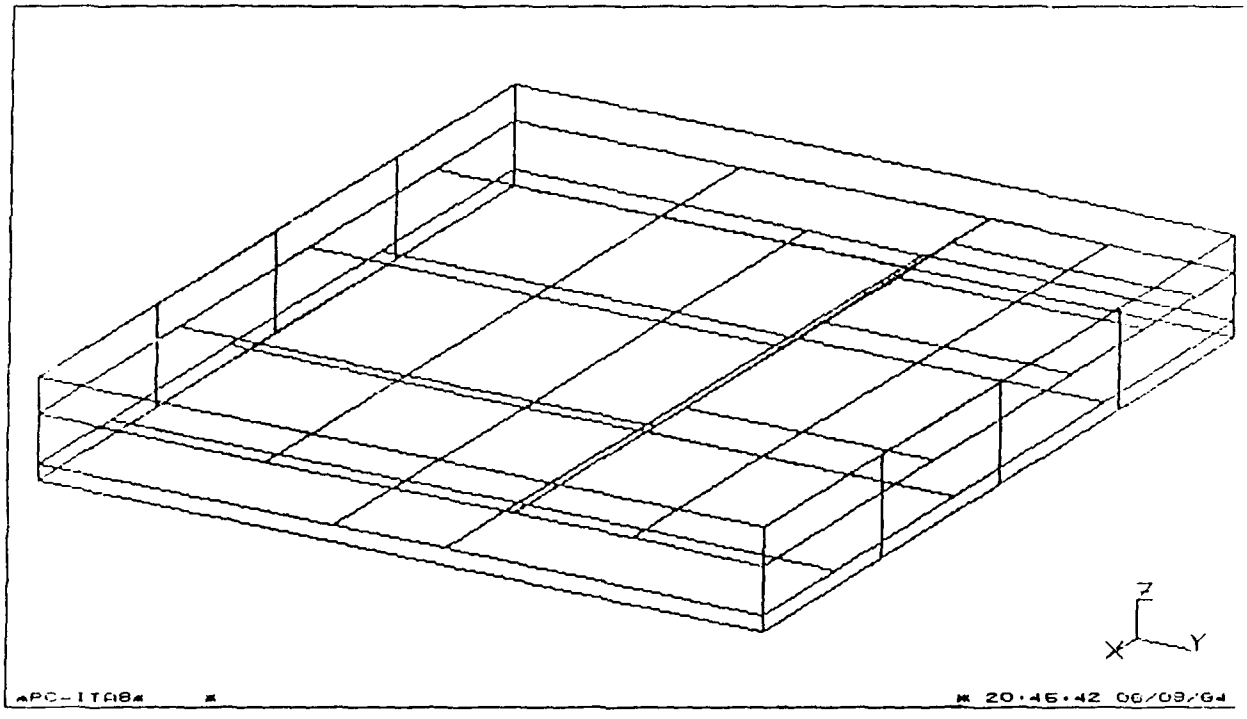
ITAS Property Data Entry (See F2) Ctrl : Copy

Seq	Surface No	NodeNo	Alpha	Emiss	T/Mass	Dissip	MID	Comments
25	3.03	25	0	.01	1.	0.		PCB 1-2
26	3.04	26	0	.01	1.	0.		PCB 1-2
27	3.05	27	0	.01	1.	0.		PCB 1-2
28	3.06	28	0	.01	1.	0.		PCB 1-2
29	3.07	29	0	.01	1.	0.		PCB 1-2
30	3.08	30	0	.01	1.	0.		PCB 1-2
31	4.01	31	0	.01	1.	0.		PCB 2 (BOTTOM)
32	4.02	32	0	.01	1.	0.		PCB 2 (BOTTOM)
33	4.03	33	0	.01	1.	0.		PCB 2 (BOTTOM)
34	4.04	34	0	.01	1.	0.		PCB 2 (BOTTOM)
35	4.05	35	0	.01	1.	0.		PCB 2 (BOTTOM)
36	4.06	36	0	.01	1.	0.		PCB 2 (BOTTOM)
37	4.07	37	0	.01	1.	0.		PCB 2 (BOTTOM)
38	4.08	38	0	.01	1.	0.		PCB 2 (BOTTOM)
39	4.09	39	0	.01	1.	0.		PCB 2 (BOTTOM)
40	4.10	40	0	.01	1.	0.		PCB 2 (BOTTOM)
41	4.11	41	0	.01	1.	0.		PCB 2 (BOTTOM)
42	4.12	42	0	.01	1.	0.		PCB 2 (BOTTOM)

S-F1Load/Save All S-F4Auto TM UDC Allowed ESCQuit

F1Load/Save Page F3PropLib F4AutoGen F5ImportPropFmt F6NewPropFile F10Search

APPENDIX D EPS THERMAL MODEL SCHEMATIC



APPENDIX E ITAS NODE CONDUCTANCES

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit

 SqNo  FACTOR  From    To      Cond. Value   L/R  Description
    1      1      1     901     1000          L   GEO NODES-THERM NODES(HOUS) +X
    2      1      2     902     1000          L   +Y
    3      1      3     903     1000          L   +Y
    4      1      4     904     1000          L   +Y
    5      1      5     905     1000          L   +Y
    6      1      6     906     1000          L   +Z
    7      1      7     907     1000          L   -X
    8      1      8     908     1000          L   -Y
    9      1      9     909     1000          L   -Y
   10      1     10     910     1000          L   -Y
   11      1     11     911     1000          L   -Y
   12      1     12     912     1000          L   -Z
   13      1     13     609     1000          L   GEO NODES TO TOP PCB THERM LAYER
   14      1     14     610     1000          L
   15      1     15     611     1000          L
   16      1     16     612     1000          L
   17      1     17     613     1000          L
   18      1     18     614     1000          L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed                PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit

 SqNo  FACTOR  From    To      Cond. Value   L/R  Description
   19      1     19     615     1000          L
   20      1     20     616     1000          L
   21      1     21     617     1000          L
   22      1     22     618     1000          L
   23      1     23     601     1000          L
   24      1     24     602     1000          L
   25      1     25     603     1000          L
   26      1     26     604     1000          L
   27      1     27     605     1000          L
   28      1     28     606     1000          L
   29      1     29     607     1000          L
   30      1     30     608     1000          L
   31      1     31    1601     1000          L   GEO NODES TO BOTTOM PCB THRM LYR
   32      1     32    1602     1000          L
   33      1     33    1603     1000          L
   34      1     34    1604     1000          L
   35      1     35    1605     1000          L
   36      1     36    1606     1000          L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed                PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value  L/R Description
   37 1      37      1607    1000          L
   38 1      38      1608    1000          L
   39 1      39      1609    1000          L
   40 1      40      1610    1000          L
   41 1      41      1611    1000          L
   42 1      42      1612    1000          L
   43 1      -913    906     125.366       L  EPS HOUSING TO EQUIP PLATE
   44 1      901     905     .2638         L  HOUSING NODES TO HOUSING NODES
   45 1      901     906     1.2592        L
   46 1      901     911     .2638         L
   47 1      901     912     1.2592        L
   48 1      902     903     .6011         L
   49 1      902     906     .3911         L
   50 1      902     907     .2638         L
   51 1      902     912     .3911         L
   52 1      903     904     .6011         L
   53 1      903     906     .3911         L
   54 1      903     912     .3911         L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value  L/R Description
       1      904     905     .6011         L
       1      904     906     .3911         L
       1      904     912     .3911         L
       1      905     906     .3911         L
       1      905     912     .3911         L
       1      907     906     .3911         L
       1      907     908     .2638         L
       1      907     912     .3911         L
       1      908     906     .3911         L
       1      908     909     .6011         L
       1      908     912     .3911         L
       1      909     906     .3911         L
       1      909     910     .6011         L
       1      909     912     .3911         L
       1      910     906     .3911         L
       1      910     911     .6011         L
       1      910     912     .3911         L
       1      911     906     .3911         L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From   To     Cond. Value  L/R Description                       º
º      1      911    912    .3911        L                                    º
º      1      921    901    .5855        L  +Y BOTTOM RAIL TO HOUSING         º
º      1      921    907    .5855        L                                    º
º      1      921    908    10.775       L                                    º
º      1      921    909    10.775       L                                    º
º      1      921    910    10.775       L                                    º
º      1      921    911    10.775       L                                    º
º      1      921    912    39.7438      L                                    º
º      1      922    901    .1611        L  +Y MIDDLE RAIL TO HOUSING         º
º      1      922    907    .1611        L                                    º
º      1      922    908    29.6528      L                                    º
º      1      922    909    29.6528      L                                    º
º      1      922    910    29.6528      L                                    º
º      1      922    911    29.6528      L                                    º
º      1      923    901    .1173        L  +Y TOP RAIL TO HOUSING            º
º      1      923    907    .1173        L                                    º
º      1      923    908    21.5921      L                                    º
º      1      923    909    21.5921      L                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From   To     Cond. Value  L/R Description                       º
º      1      923    910    21.5921      L                                    º
º      1      923    911    21.5921      L                                    º
º      1      923    906    27.9466      L                                    º
º      1      924    901    .05855       L  -Y BOTTOM RAIL TO HOUSING         º
º      1      924    907    .05855       L                                    º
º      1      924    908    10.775       L                                    º
º      1      924    909    10.775       L                                    º
º      1      924    910    10.775       L                                    º
º      1      924    911    10.775       L                                    º
º      1      924    912    39.7438      L                                    º
º      1      925    901    .1611        L  -Y MIDDLE RAIL TO HOUSING         º
º      1      925    907    .1611        L                                    º
º      1      925    908    29.6528      L                                    º
º      1      925    909    29.6528      L                                    º
º      1      925    910    29.6528      L                                    º
º      1      925    911    29.6528      L                                    º
º      1      926    901    .1173        L  -Y TOP RAIL TO HOUSING            º
º      1      926    907    .1173        L                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From   To     Cond. Value  L/R Description                       º
º      1      926    908    21.5921       L                                    º
º      1      926    909    21.5921       L                                    º
º      1      926    910    21.5921       L                                    º
º      1      926    911    21.5921       L                                    º
º      1      926    906    27.9466       L                                    º
º      1      1601   924    1.4967        L  BOT PCB THRM LYR TO -Y BOT RAIL   º
º      1      1602   924    1.7213        L                                    º
º      1      1603   924    1.347         L                                    º
º      1      1604   924    .8232         L                                    º
º      1      1609   921    1.4967        L  BOT PCB THRM LYR TO +Y BOT RAIL   º
º      1      1610   921    1.7213        L                                    º
º      1      1611   921    1.347         L                                    º
º      1      1612   921    .8232         L                                    º
º      1      1101   925    .0027         L  BOT PCB TP POLY LYR TO -Y MID RL  º
º      1      1102   925    .0031         L                                    º
º      1      1103   925    .0024         L                                    º
º      1      1104   925    .0014         L                                    º
º      1      1109   922    .0027         L  BOT PCB TP POLY LYR TO +Y MID RL  º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From   To     Cond. Value  L/R Description                       º
º      1      1110   922    .0031         L                                    º
º      1      1111   922    .0024         L                                    º
º      1      1112   922    .0014         L                                    º
º      1      601    925    .8007         L  TOP PCB THRM LYR TO -Y MID RAIL   º
º      1      602    925    1.2811        L                                    º
º      1      603    925    1.2945        L                                    º
º      1      604    925    1.962         L                                    º
º      1      614    922    .4003         L  TOP PCB THRM LYR TO +Y MID RAIL   º
º      1      615    922    .5338         L                                    º
º      1      616    922    .7340         L                                    º
º      1      617    922    1.3986        L                                    º
º      1      618    922    1.7351        L                                    º
º      1      101    926    .0016         L  TOP PCB TP POLY LYR TO -Y TP RAIL º
º      1      102    926    .0026         L                                    º
º      1      103    926    .0026         L                                    º
º      1      104    926    .0039         L                                    º
º      1      114    923    .0008         L                                    º
º      1      115    923    .001          L                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value   L/R Description                    º
º      1      116     923     .0014          L                                 º
º      1      117     923     .0028          L                                 º
º      1      118     923     .0035          L                                 º
º      1      601     602     .01657         L  TOP PCB THRM LYR NODE TO NODE  º
º      1      601     605     .00738         L                                 º
º      1      602     603     .0134          L                                 º
º      1      602     606     .01183         L                                 º
º      1      603     604     .01267         L                                 º
º      1      603     607     .01194         L                                 º
º      1      604     608     .01315         L                                 º
º      1      605     606     .01825         L                                 º
º      1      605     609     .00306         L                                 º
º      1      605     610     .00306         L                                 º
º      1      606     607     .01475         L                                 º
º      1      606     610     .00159         L                                 º
º      1      606     611     .00874         L                                 º
º      1      606     612     .00493         L                                 º
º      1      607     608     .01396         L                                 º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value   L/R Description                    º
º      1      607     612     .01177         L                                 º
º      1      607     613     .00366         L                                 º
º      1      608     613     .01702         L                                 º
º      1      609     610     .0194          L                                 º
º      1      609     614     .00452         L                                 º
º      1      610     611     .0143          L                                 º
º      1      610     615     .0094          L                                 º
º      1      611     612     .00849         L                                 º
º      1      611     616     .0129          L                                 º
º      1      612     613     .00578         L                                 º
º      1      612     617     .01156         L                                 º
º      1      613     618     .03059         L                                 º
º      1      615     614     .02128         L                                 º
º      1      615     616     .01826         L                                 º
º      1      617     616     .01084         L                                 º
º      1      617     618     .01577         L                                 º
º      1      401     402     .01657         L  TOP PCB GROUND LYR NODE TO NODE º
º      1      401     405     .00738         L                                 º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value   L/R Description
       1      402     403     .0134          L
       1      402     406     .01183         L
       1      403     404     .01267         L
       1      403     407     .01194         L
       1      404     408     .01315         L
       1      405     406     .01825         L
       1      405     409     .00306         L
       1      405     410     .00306         L
       1      406     407     .01475         L
       1      406     410     .00159         L
       1      406     411     .00874         L
       1      406     412     .00493         L
       1      407     408     .01396         L
       1      407     412     .01177         L
       1      407     413     .00366         L
       1      408     413     .01702         L
       1      409     410     .0194          L
       1      409     414     .00452         L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value   L/R Description
       1      410     411     .0143          L
       1      410     415     .0094          L
       1      411     412     .00849         L
       1      411     416     .01291         L
       1      412     413     .00578         L
       1      412     417     .01156         L
       1      413     418     .03059         L
       1      415     414     .02128         L
       1      415     416     .01826         L
       1      417     416     .01084         L
       1      417     418     .01577         L
       1      501     502     .0001          L  TOP PCB 5TH LYR NODETONODE-POLY
       1      501     505     .0001          L
       1      502     503     .0001          L
       1      502     506     .0001          L
       1      503     504     .0001          L
       1      503     507     .0001          L
       1      504     508     .0001          L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

èëë Ctrl:Copyëëëëëëëëëëëëë ITAS Conductor Data Entry ëëëëëëëëëëëëëëë ESC:Quit £

SqNo	FACTOR	From	To	Cond. Value	L/R	Description
217	1	505	506	.0001	L	
218	1	505	509	.00003	L	
219	1	505	510	.00003	L	
220	1	506	507	.0001	L	
221	1	506	510	.00001	L	
222	1	506	511	.00006	L	
223	1	506	512	.00003	L	
224	1	507	508	.0001	L	
225	1	507	512	.0001	L	
226	1	507	513	.00003	L	
227	1	508	513	.0001	L	
228	1	509	510	.0001	L	
229	1	509	514	.00005	L	
230	1	510	511	.0001	L	
231	1	510	515	.0001	L	
232	1	511	512	.0001	L	
233	1	511	516	.0001	L	
234	1	512	513	.0001	L	

CTRL-F1Import ITAS_NC ALT-F3AutoMLI UDC Allowed PgDn PgUp Home
SHFT-F1Import Column Shift-F3AutoCHT Shift-F5Del/Pur End
F1Save/Purge F2Help F3AutoGen F4Purge F5Delete F7Mark/UnMark F10Search

èëë Ctrl:Copyëëëëëëëëëëëëë ITAS Conductor Data Entry ëëëëëëëëëëëëëëë ESC:Quit £

SqNo	FACTOR	From	To	Cond. Value	L/R	Description
235	1	512	517	.0001	L	
236	1	513	518	.00023	L	
237	1	515	514	.0001	L	
238	1	515	516	.0001	L	
239	1	517	516	.0001	L	
240	1	517	518	.0001	L	
241	1	601	501	.0126	L	TOP PCB LAYER TO LAYER
242	1	602	502	.0202	L	
243	1	603	503	.0204	L	
244	1	604	504	.0225	L	
245	1	605	505	.0139	L	
246	1	606	506	.0222	L	
247	1	607	507	.0225	L	
248	1	608	508	.0071	L	
249	1	609	509	.0033	L	
250	1	610	510	.0044	L	
251	1	611	511	.006	L	
252	1	612	512	.0117	L	

CTRL-F1Import ITAS_NC ALT-F3AutoMLI UDC Allowed PgDn PgUp Home
SHFT-F1Import Column Shift-F3AutoCHT Shift-F5Del/Pur End
F1Save/Purge F2Help F3AutoGen F4Purge F5Delete F7Mark/UnMark F10Search

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit £
¤                                                                              ¤
¤ SqNo FACTOR From    To      Cond. Value  L/R Description                     ¤
¤      1      613     513     .0144         L                                  ¤
¤      1      614     514     .0036         L                                  ¤
¤      1      615     515     .0048         L                                  ¤
¤      1      616     516     .0066         L                                  ¤
¤      1      617     517     .0128         L                                  ¤
¤      1      618     518     .0157         L                                  ¤
¤      1      501     401     .0126         L                                  ¤
¤      1      502     402     .0202         L                                  ¤
¤      1      503     403     .0204         L                                  ¤
¤      1      504     404     .0225         L                                  ¤
¤      1      505     405     .0139         L                                  ¤
¤      1      506     406     .0222         L                                  ¤
¤      1      507     407     .0225         L                                  ¤
¤      1      508     408     .0071         L                                  ¤
¤      1      509     409     .0033         L                                  ¤
¤      1      510     410     .0044         L                                  ¤
¤      1      511     411     .006          L                                  ¤
¤      1      512     412     .0117         L                                  ¤
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit £
¤                                                                              ¤
¤ SqNo FACTOR From    To      Cond. Value  L/R Description                     ¤
¤  271 1      513     413     .0144         L                                  ¤
¤  272 1      514     414     .0036         L                                  ¤
¤  273 1      515     415     .0048         L                                  ¤
¤  274 1      516     416     .0066         L                                  ¤
¤  275 1      517     417     .0128         L                                  ¤
¤  276 1      518     418     .0157         L                                  ¤
¤  277 1      401     301     .0126         L                                  ¤
¤  278 1      402     302     .0202         L                                  ¤
¤  279 1      403     303     .0204         L                                  ¤
¤  280 1      404     304     .0225         L                                  ¤
¤  281 1      405     305     .0139         L                                  ¤
¤  282 1      406     306     .0222         L                                  ¤
¤  283 1      407     307     .0225         L                                  ¤
¤  284 1      408     308     .0071         L                                  ¤
¤  285 1      409     309     .0033         L                                  ¤
¤  286 1      410     310     .0044         L                                  ¤
¤  287 1      411     311     .006          L                                  ¤
¤  288 1      412     312     .0117         L                                  ¤
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value  L/R Description
  289 1      413     313     .0144         L
  290 1      414     314     .0036         L
  291 1      415     315     .0048         L
  292 1      416     316     .0066         L
  293 1      417     317     .0128         L
  294 1      418     318     .0157         L
  295 1      301     201     .0126         L
  296 1      302     202     .0202         L
  297 1      303     203     .0204         L
  298 1      304     204     .0225         L
  299 1      305     205     .0139         L
  300 1      306     206     .0222         L
  301 1      307     207     .0225         L
  302 1      308     208     .0071         L
  303 1      309     209     .0033         L
  304 1      310     210     .0044         L
  305 1      311     211     .006          L
  306 1      312     212     .0117         L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
Ctrl:Copy                ITAS Conductor Data Entry                ESC:Quit
 SqNo FACTOR From    To      Cond. Value  L/R Description
  307 1      313     213     .0144         L
  308 1      314     214     .0036         L
  309 1      315     215     .0048         L
  310 1      316     216     .0066         L
  311 1      317     217     .0128         L
  312 1      318     218     .0157         L
  313 1      201     101     .0126         L
  314 1      202     102     .0202         L
  315 1      203     103     .0204         L
  316 1      204     104     .0225         L
  317 1      205     105     .0139         L
  318 1      206     106     .0222         L
  319 1      207     107     .0225         L
  320 1      208     108     .0071         L
  321 1      209     109     .0033         L
  322 1      210     110     .0044         L
  323 1      211     111     .006          L
  324 1      212     112     .0117         L
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl·CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value   L/R Description                    º
º  325 1      213     113     .0144          L                                 º
º  326 1      214     114     .0036          L                                 º
º  327 1      215     115     .0144          L                                 º
º  328 1      216     116     .0066          L                                 º
º  329 1      217     117     .0128          L                                 º
º  330 1      218     118     .0157          L                                 º
º  331 1      1601    1602    .0168          L  BOT PCB THRM LYR NODE TO NODE  º
º  332 1      1601    1605    .0136          L                                 º
º  333 1      1602    1603    .0176          L                                 º
º  334 1      1602    1606    .0156          L                                 º
º  335 1      1603    1604    .0249          L                                 º
º  336 1      1603    1607    .0122          L                                 º
º  337 1      1604    1608    .0074          L                                 º
º  338 1      1605    1606    .006           L                                 º
º  339 1      1605    1609    .0143          L                                 º
º  340 1      1606    1607    .0063          L                                 º
º  341 1      1606    1610    .0165          L                                 º
º  342 1      1607    1608    .0089          L                                 º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value   L/R Description                    º
º  343 1      1607    1611    .0129          L                                 º
º  344 1      1608    1612    .0079          L                                 º
º  345 1      1609    1610    .0156          L                                 º
º  346 1      1610    1611    .0164          L                                 º
º  347 1      1611    1612    .0231          L                                 º
º  348 1      1401    1402    .0168          L  BOT PCB GROUND LYR NODE TO NODE º
º  349 1      1401    1405    .0136          L                                 º
º  350 1      1402    1403    .0176          L                                 º
º  351 1      1402    1406    .0156          L                                 º
º  352 1      1403    1404    .0249          L                                 º
º  353 1      1403    1407    .0122          L                                 º
º  354 1      1404    1408    .0074          L                                 º
º  355 1      1405    1406    .006           L                                 º
º  356 1      1405    1409    .0143          L                                 º
º  357 1      1406    1407    .0063          L                                 º
º  358 1      1406    1410    .0165          L                                 º
º  359 1      1407    1408    .0089          L                                 º
º  360 1      1407    1411    .0129          L                                 º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value  L/R Description                     º
º  361 1      1408    1412    .0079         L                                  º
º  362 1      1409    1410    .0156         L                                  º
º  363 1      1410    1411    .0164         L                                  º
º  364 1      1411    1412    .0231         L                                  º
º  365 1      1501    1502    .0001         L  BOT PCB 5TH LYR NODETONODE (POLY) º
º  366 1      1501    1505    .0001         L                                  º
º  367 1      1502    1503    .0001         L                                  º
º  368 1      1502    1506    .0001         L                                  º
º  369 1      1503    1504    .0001         L                                  º
º  370 1      1503    1507    .0001         L                                  º
º  371 1      1504    1508    .0001         L                                  º
º  372 1      1505    1506    .0001         L                                  º
º  373 1      1505    1509    .0001         L                                  º
º  374 1      1506    1507    .0001         L                                  º
º  375 1      1506    1510    .0001         L                                  º
º  376 1      1507    1508    .0001         L                                  º
º  377 1      1507    1511    .0001         L                                  º
º  378 1      1508    1512    .0001         L                                  º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËË Ctrl:CopyËËËËËËËËËËËËËË ITAS Conductor Data Entry ËËËËËËËËËËËËËËË ESC:Quit É
º                                                                              º
º SqNo FACTOR From    To      Cond. Value  L/R Description                     º
º  379 1      1509    1510    .0001         L                                  º
º  380 1      1510    1511    .0001         L                                  º
º  381 1      1511    1512    .0001         L                                  º
º  382 1      1601    1501    .0295         L  BOT PCB LAYER TO LAYER          º
º  383 1      1602    1502    .0339         L                                  º
º  384 1      1603    1503    .0266         L                                  º
º  385 1      1604    1504    .0162         L                                  º
º  386 1      1605    1505    .0105         L                                  º
º  387 1      1606    1506    .0121         L                                  º
º  388 1      1607    1507    .0095         L                                  º
º  389 1      1608    1508    .0058         L                                  º
º  390 1      1609    1509    .0274         L                                  º
º  391 1      1610    1510    .0315         L                                  º
º  392 1      1611    1511    .0247         L                                  º
º  393 1      1612    1512    .015          L                                  º
º  394 1      1501    1401    .0295         L                                  º
º  395 1      1502    1402    .0339         L                                  º
º  396 1      1503    1403    .0266         L                                  º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHIFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÚÄÄ Ctrl:CopyÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ITAS Conductor Data Entry ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ESC:Quit ¿
³                                                                          ³
³ SqNo FACTOR From   To     Cond. Value  L/R Description                    ³
³  397 1      1504   1404   .0162         L                                 ³
³  398 1      1505   1405   .0105         L                                 ³
³  399 1      1506   1406   .0121         L                                 ³
³  400 1      1507   1407   .0095         L                                 ³
³  401 1      1508   1408   .0058         L                                 ³
³  402 1      1509   1409   .0274         L                                 ³
³  403 1      1510   1410   .0315         L                                 ³
³  404 1      1511   1411   .0247         L                                 ³
³  405 1      1512   1412   .015          L                                 ³
³  406 1      1401   1301   .0295         L                                 ³
³  407 1      1402   1302   .0339         L                                 ³
³  408 1      1403   1303   .0266         L                                 ³
³  409 1      1404   1304   .0162         L                                 ³
³  410 1      1405   1305   .0105         L                                 ³
³  411 1      1406   1306   .0121         L                                 ³
³  412 1      1407   1307   .0095         L                                 ³
³  413 1      1408   1308   .0058         L                                 ³
³  414 1      1409   1309   .0274         L                                 ³
ÀÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI   UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÚÄÄ Ctrl:CopyÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ITAS Conductor Data Entry ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ESC:Quit ¿
³                                                                          ³
³ SqNo FACTOR From   To     Cond. Value  L/R Description                    ³
³  415 1      1410   1310   .0315         L                                 ³
³  416 1      1411   1311   .0247         L                                 ³
³  417 1      1412   1312   .015          L                                 ³
³  418 1      1301   1201   .0295         L                                 ³
³  419 1      1302   1202   .0339         L                                 ³
³  420 1      1303   1203   .0266         L                                 ³
³  421 1      1304   1204   .0162         L                                 ³
³  422 1      1305   1205   .0105         L                                 ³
³  423 1      1306   1206   .0121         L                                 ³
³  424 1      1307   1207   .0095         L                                 ³
³  425 1      1308   1208   .0058         L                                 ³
³  426 1      1309   1209   .0274         L                                 ³
³  427 1      1310   1210   .0315         L                                 ³
³  428 1      1311   1211   .0247         L                                 ³
³  429 1      1312   1212   .015          L                                 ³
³  430 1      1201   1101   .0295         L                                 ³
³  431 1      1202   1102   .0339         L                                 ³
³  432 1      1203   1103   .0266         L                                 ³
ÀÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI   UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT   Shift-F5Del/Pur                End
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÚÄÄ Ctrl:CopyÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ITAS Conductor Data Entry ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ESC:Quit ¿
³                                                                          ³
³ SqNo FACTOR From    To      Cond. Value   L/R Description                ³
³  433 1       1204    1104    .0162          L                           ³
³  434 1       1205    1105    .0105          L                           ³
³  435 1       1206    1106    .0121          L                           ³
³  436 1       1207    1107    .0095          L                           ³
³  437 1       1208    1108    .0058          L                           ³
³  438 1       1209    1109    .0274          L                           ³
³  439 1       1210    1110    .0315          L                           ³
³  440 1       1211    1111    .0247          L                           ³
³  441 1       1212    1112    .015           L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
³       1                                     L                           ³
ÀÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÙ
CTRL-F1Import ITAS_NC     ALT-F3AutoMLI    UDC Allowed              PgDn PgUp Home
SHFT-F1Import Column    Shift-F3AutoCHT    Shift-F5Del/Pur                End
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

APPENDIX F ITAS NODE DATA FOR COLD-CASE

ÉÈCtrl:CopyÈÈÈÈÈÈÈ ITAS Node Data Entry For Thermal Analysis ÈÈÈÈÈÈÈÈESC:QuitÈ£

SEQN	NodeNo	Temp-C	ThrMass	Dissip	Comment
	901	20		0	EPS HOUSING WALLS +X
	902	20		0	+Y
	903	20		0	+Y
	904	20		0	+Y
	905	20		0	+Y
	906	20		0	+Z
	907	20		0	-X
	908	20		0	-Y
	909	20		0	-Y
	910	20		0	-Y
	911	20		0	-Y
	912	20		0	-Z
	-913	0		0	BOUNDARY NODE TO 906
	921	20		0	HOUSING +Y BOTTOM RAIL
	922	20		0	+Y MIDDLE RAIL
	923	20		0	+Y TOP RAIL
	924	20		0	-Y BOTTOM RAIL
	925	20		0	-Y MIDDLE RAIL

CTRL-F1Import ITAS_NC UDC Allowed PgDn PgUp Home End
SHIFT-F1Import Column Shift-F5Del/Pur
F1Save/Purge F2Help F3AutoGen F4Purge F5Delete F7Mark/UnMark F10Search

ÉÈCtrl:CopyÈÈÈÈÈÈÈ ITAS Node Data Entry For Thermal Analysis ÈÈÈÈÈÈÈÈESC:QuitÈ£

SEQN	NodeNo	Temp-C	ThrMass	Dissip	Comment
	926	20		0	-Y TOP RAIL
	601	20		.058	TOP PCB THERMAL PLANE
	602	20		.070	
	603	20		.026	
	604	20		.001	
	605	20		0	
	606	20		0	
	607	20		0	
	608	20		0	
	609	20		0	
	610	20		0	
	611	20		0	
	612	20		0	
	613	20		0	
	614	20		0	
	615	20		0	
	616	20		0	
	617	20		0	

CTRL-F1Import ITAS_NC UDC Allowed PgDn PgUp Home End
SHIFT-F1Import Column Shift-F5Del/Pur
F1Save/Purge F2Help F3AutoGen F4Purge F5Delete F7Mark/UnMark F10Search

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º   37    618       20                  0                                    º
º   38    501       20                  0         5TH LAYER POLYIMIDE        º
º   39    502       20                  0                                    º
º   40    503       20                  0                                    º
º   41    504       20                  0                                    º
º   42    505       20                  0                                    º
º   43    506       20                  0                                    º
º   44    507       20                  0                                    º
º   45    508       20                  0                                    º
º   46    509       20                  0                                    º
º   47    510       20                  0                                    º
º   48    511       20                  0                                    º
º   49    512       20                  0                                    º
º   50    513       20                  0                                    º
º   51    514       20                  0                                    º
º   52    515       20                  0                                    º
º   53    516       20                  0                                    º
º   54    517       20                  0                                    º
ÈËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÍ
CTRL-F1Import ITAS_NC   UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         518       20                  .003      GROUND LAYER  COPPER         º
º         401       20                  .004                                   º
º         402       20                  .001                                   º
º         403       20                  .001                                   º
º         404       20                  0                                      º
º         405       20                  0                                      º
º         406       20                  0                                      º
º         407       20                  0                                      º
º         408       20                  0                                      º
º         409       20                  0                                      º
º         410       20                  0                                      º
º         411       20                  0                                      º
º         412       20                  0                                      º
º         413       20                  0                                      º
º         414       20                  0                                      º
º         415       20                  0                                      º
º         416       20                  0                                      º
º         417       20                  0                                      º
ÈËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÍ
CTRL-F1Import ITAS_NC   UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
èëCtrl:Copyëëëëëëë ITAS Node Data Entry For Thermal Analysis ëëëëëëëëESC:Quitëë
n                                                                                n
n SEQN     NodeNo    Temp-C    ThrMass   Dissip    Comment                       n
n          418       20                  0                                       n
n          301       20                  0         3RD LAYER POLYIMIDE           n
n          302       20                  0                                       n
n          303       20                  0                                       n
n          304       20                  0                                       n
n          305       20                  0                                       n
n          306       20                  0                                       n
n          307       20                  0                                       n
n          308       20                  0                                       n
n          309       20                  0                                       n
n          310       20                  0                                       n
n          311       20                  0                                       n
n          312       20                  0                                       n
n          313       20                  0                                       n
n          314       20                  0                                       n
n          315       20                  0                                       n
n          316       20                  0                                       n
n          317       20                  0                                       n
àëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëV
CTRL-F1Import ITAS_NC    UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                        Shift-F5Del/Pur
    F1Save/Purge       F2Help F3AutoGen F4Purge F5Delete   F7Mark/UnMark F10Search
```

```
èëCtrl:Copyëëëëëëë ITAS Node Data Entry For Thermal Analysis ëëëëëëëëESC:Quitëë
n                                                                                n
n SEQN     NodeNo    Temp-C    ThrMass   Dissip    Comment                       n
n          318       20                  0                                       n
n          201       20                  0         SIGNAL LEVEL (VERY LITTLE CU) n
n          202       20                  0                                       n
n          203       20                  0                                       n
n          204       20                  0                                       n
n          205       20                  0                                       n
n          206       20                  0                                       n
n          207       20                  0                                       n
n          208       20                  0                                       n
n          209       20                  0                                       n
n          210       20                  0                                       n
n          211       20                  0                                       n
n          212       20                  0                                       n
n          213       20                  0                                       n
n          214       20                  0                                       n
n          215       20                  0                                       n
n          216       20                  0                                       n
n          217       20                  0                                       n
àëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëëV
CTRL F1Import ITAS_NC    UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                        Shift-F5Del/Pur
    F1Save/Purge       F2Help F3AutoGen F4Purge F5Delete   F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         218       20                  0                                    º
º         101       20                  0         TOP LAYER POLYIMIDE        º
º         102       20                  0                                    º
º         103       20                  0                                    º
º         104       20                  0                                    º
º         105       20                  0                                    º
º         106       20                  0                                    º
º         107       20                  0                                    º
º         108       20                  0                                    º
º         109       20                  0                                    º
º         110       20                  0                                    º
º         111       20                  0                                    º
º         112       20                  0                                    º
º         113       20                  0                                    º
º         114       20                  0                                    º
º         115       20                  0                                    º
º         116       20                  0                                    º
º         117       20                  0                                    º
ÈËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÍ
CTRL-F1Import ITAS_NC   UDC Allowed                        PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         118       20                  0                                    º
º         1601      20                  0         BOTTOM PCB THERMAL PLANE COPPER  º
º         1602      20                  0                                    º
º         1603      20                  0                                    º
º         1604      20                  0                                    º
º         1605      20                  0                                    º
º         1606      20                  0                                    º
º         1607      20                  0                                    º
º         1608      20                  0                                    º
º         1609      20                  0                                    º
º         1610      20                  0                                    º
º         1611      20                  0                                    º
º         1612      20                  0                                    º
º         1613      20                  0                                    º
º         1614      20                  0                                    º
º         1615      20                  0                                    º
º         1616      20                  0                                    º
º         1617      20                  0                                    º
ÈËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÍ
CTRL-F1Import ITAS_NC   UDC Allowed                        PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1618      20                  0                                    º
º         1501      20                  0         5TH LAYER POLYIMIDE        º
º         1502      20                  0                                    º
º         1503      20                  0                                    º
º         1504      20                  0                                    º
º         1505      20                  0                                    º
º         1506      20                  0                                    º
º         1507      20                  0                                    º
º         1508      20                  0                                    º
º         1509      20                  0                                    º
º         1510      20                  0                                    º
º         1511      20                  0                                    º
º         1512      20                  0                                    º
º         1513      20                  0                                    º
º         1514      20                  0                                    º
º         1515      20                  0                                    º
º         1516      20                  0                                    º
º         1517      20                  0                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC   UDC Allowed                        PgDn PgUp Home End
SHFT-F1Import Column                        Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1518      20                  0                                    º
º         1401      20                  0         GROUND LAYER COPPER        º
º         1402      20                  0                                    º
º         1403      20                  0                                    º
º         1404      20                  0                                    º
º         1405      20                  0                                    º
º         1406      20                  0                                    º
º         1407      20                  0                                    º
º         1408      20                  0                                    º
º         1409      20                  0                                    º
º         1410      20                  0                                    º
º         1411      20                  0                                    º
º         1412      20                  0                                    º
º         1413      20                  0                                    º
º         1414      20                  0                                    º
º         1415      20                  0                                    º
º         1416      20                  0                                    º
º         1417      20                  0                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import ITAS_NC   UDC Allowed                        PgDn PgUp Home End
SHFT-F1Import Column                        Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1418      20                  0                                    º
º         1301      20                  0         3RD LAYER POLYIMIDE        º
º         1302      20                  0                                    º
º         1303      20                  0                                    º
º         1304      20                  0                                    º
º         1305      20                  0                                    º
º         1306      20                  0                                    º
º         1307      20                  0                                    º
º         1308      20                  0                                    º
º         1309      20                  0                                    º
º         1310      20                  0                                    º
º         1311      20                  0                                    º
º         1312      20                  0                                    º
º         1313      20                  0                                    º
º         1314      20                  0                                    º
º         1315      20                  0                                    º
º         1316      20                  0                                    º
º         1317      20                  0                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC   UDC Allowed                    PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1318      20                  0                                    º
º         1201      20                  0         SIGNAL LAYER COPPER        º
º         1202      20                  0                                    º
º         1203      20                  0                                    º
º         1204      20                  0                                    º
º         1205      20                  0                                    º
º         1206      20                  0                                    º
º         1207      20                  0                                    º
º         1208      20                  0                                    º
º         1209      20                  0                                    º
º         1210      20                  0                                    º
º         1211      20                  0                                    º
º         1212      20                  0                                    º
º         1213      20                  0                                    º
º         1214      20                  0                                    º
º         1215      20                  0                                    º
º         1216      20                  0                                    º
º         1217      20                  0                                    º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC   UDC Allowed                    PgDn PgUp Home End
SHFT-F1Import Column                          Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈÉCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1218      20                  0                                    º
º         1101      20                  0         TOP LAYER POLYIMIDE        º
º         1102      20                  0                                    º
º         1103      20                  0                                    º
º         1104      20                  0                                    º
º         1105      20                  0                                    º
º         1106      20                  0                                    º
º         1107      20                  0                                    º
º         1108      20                  0                                    º
º         1109      20                  0                                    º
º         1110      20                  0                                    º
º         1111      20                  0                                    º
º         1112      20                  0                                    º
º         1113      20                  0                                    º
º         1114      20                  0                                    º
º         1115      20                  0                                    º
º         1116      20                  0                                    º
º         1117      20                  0                                    º
ÀÊËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC    UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                              Shift-F5Del/Pur
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËËESC:QuitËÍ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º         1118      20                  0                                    º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
º                                                                              º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÝ
CTRL-F1Import ITAS_NC    UDC Allowed                          PgDn PgUp Home End
SHFT-F1Import Column                              Shift-F5Del/Pur
     F1Save/Purge      F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

APPENDIX G ITAS NODE DATA FOR HOT-CASE

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º    1    901       20                  0         EPS HOUSING WALLS +X         º
º    2    902       20                  0         +Y                           º
º    3    903       20                  0         +Y                           º
º    4    904       20                  0         +Y                           º
º    5    905       20                  0         +Y                           º
º    6    906       20                  0         +Z                           º
º    7    907       20                  0         -X                           º
º    8    908       20                  0         -Y                           º
º    9    909       20                  0         -Y                           º
º   10    910       20                  0         -Y                           º
º   11    911       20                  0         -Y                           º
º   12    912       20                  0         -Z                           º
º   13    -913      40                  0         BOUNDARY NODE TO 906         º
º   14    921       20                  0         HOUSING +Y BOTTOM RAIL       º
º   15    922       20                  0         +Y MIDDLE RAIL               º
º   16    923       20                  0         +Y TOP RAIL                  º
º   17    924       20                  0         -Y BOTTOM RAIL               º
º   18    925       20                  0         -Y MIDDLE RAIL               º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import 1TAS_NC   UDC Allowed                    PgDn PgUp Home End
SHFT-F1Import Column                      Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

```
ÈËCtrl:CopyËËËËËËË ITAS Node Data Entry For Thermal Analysis ËËËËËËËESC:QuitËÉ
º                                                                              º
º SEQN    NodeNo    Temp-C    ThrMass   Dissip    Comment                      º
º   19    926       20                  0         -Y TOP RAIL                  º
º   20    601       20                  .037      TOP PCB THERMAL PLANE        º
º   21    602       20                  .0475                                  º
º   22    603       20                  .01995                                 º
º   23    604       20                  .01                                    º
º   24    605       20                  .011                                   º
º   25    606       20                  .060                                   º
º   26    607       20                  .011                                   º
º   27    608       20                  0                                      º
º   28    609       20                  0                                      º
º   29    610       20                  .008                                   º
º   30    611       20                  .008                                   º
º   31    612       20                  .011                                   º
º   32    613       20                  0                                      º
º   33    614       20                  0                                      º
º   34    615       20                  .009                                   º
º   35    616       20                  .009                                   º
º   36    617       20                  .004                                   º
ÀËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËËÙ
CTRL-F1Import 1TAS_NC   UDC Allowed                    PgDn PgUp Home End
SHFT-F1Import Column                      Shift-F5Del/Pur
     F1Save/Purge     F2Help F3AutoGen F4Purge F5Delete  F7Mark/UnMark F10Search
```

èëCtrl:Copyëëëëëëë ITAS Node Data Entry For Thermal Analysis ëëëëëëëëESC:Quitë£

SEQN	NodeNo	Temp-C	ThrMass	Dissip	Comment
127	118	20		0	
128	1601	20		.113	BOTTOM PCB THERMAL PLANE COPPER
129	1602	20		.086	
130	1603	20		.025	
131	1604	20		0	
132	1605	20		0	
133	1606	20		.175	
134	1607	20		0	
135	1608	20		0	
136	1609	20		.375	
137	1610	20		.105	
138	1611	20		.15	
139	1612	20		0	
140	1613	20		0	
141	1614	20		0	
142	1615	20		0	
143	1616	20		0	
144	1617	20		0	

CTRL-F1Import ITAS_NC UDC Allowed PgDn PgUp Home End
SHFT-F1Import Column Shift-F5Del/Pur
F1Save/Purge F2Help F3AutoGen F4Purge F5Delete F7Mark/UnMark F10Search

APPENDIX H ITAS OUTPUT FOR COLD-CASE

```
 TOTAL SURFACES IN THIS MODEL=    42
 TOTAL SURFACES IN THIS MODEL=    42
*************************************************************************
                    PC-ITAS Summary of Input Parameters
          These parameters reflect the latest values assigned to them
                          prior to any computation
 TOTAL SURFACES IN THIS MODEL=    42
*************************************************************************
Date: 05/20/94                                          Time: 14:35:32.10
*************************************************************************
=========================================================================
                        Thermal Analysis Parameters
=========================================================================
 1.  Solution Method:1.Steady-State 2.Transient 3. (1&2).....          1
 2.  Solution Time Step .....(minutes).....................       0.10
 3.  Final Time (minutes);if <0 then no of orbs.............      -1.00
 4   Starting Temperature .....(Kelvin ).....................     300.00
 5.  Temperature Print Interval (minutes)...................         20
 6.  No. of Iterations For Convergence (NLOOP).............       9999
 7.  Temperature Unit 1:K, 2:C, 3:F, 4:R....................          2
 8.  Solution Accuracy Parameter (not used).................        130
 9.  Solution Convergence Parameter (not used).............       1.30
 10. Solution Tolerance (ARLXCA, DRLXCA)....................    0.00100
 11. Transient Solution Stability Factor (not used).........      0.850
 12. Include User-Defined Network.....(Y/N).................          Y
 13. Print RADK, POWER.....(Y/N)............................          N
 14. Print Transient Time/Temperature...(Y/N)...............          N
 15. Starting Temperatures Forced (No.4)(Y/N)...............          N
 16. Thermal Analyses Without Orbital Loads (Y/N)...........          Y
 17. Stand-Alone Thermal Analyzer (ITAS-Format Models)......          Y
 18. No. of Isolated Cavities (RADK files)..................          0

=========================================================================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                          *ITAS THERMAL ANALYSIS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
 ITAS THERMAL ANALYZER:
 *ERROR*DATA ERROR ENCOUNTERED
*ERROR* FOR CODE=
 END OF RADIATION CONDUCTANCE & POWER PROCESSING
 THERMAL DATA PREP ERROR CODE=          1
*************************************************************************
Date: 05/20/94                                          Time: 14:38:44.10
*************************************************************************
=========================================================================
                        Thermal Analysis Parameters
=========================================================================
 1.  Solution Method:1.Steady-State 2.Transient 3. (1&2).....          1
 2.  Solution Time Step .....(minutes).....................       0.10
 3.  Final Time (minutes);if <0 then no of orbs.............      -1.00
 4.  Starting Temperature .....(Kelvin ).....................     300.00
 5.  Temperature Print Interval (minutes)...................         20
 6.  No. of Iterations For Convergence (NLOOP).............       9999
 7.  Temperature Unit 1:K, 2:C, 3:F, 4:R....................          2
 8.  Solution Accuracy Parameter (not used).................        130
 9.  Solution Convergence Parameter (not used).............       1.30
 10. Solution Tolerance (ARLXCA, DRLXCA)....................    0.00100
 11. Transient Solution Stability Factor (not used).........      0.850
```

```
 12. Include User-Defined Network.....(Y/N).....          Y
 13. Print RADK, POWER.....(Y/N).....                     N
 14. Print Transient Time/Temperature...(Y/N).....        N
 15. Starting Temperatures Forced (No.4)(Y/N).....        N
 16. Thermal Analyses Without Orbital Loads (Y/N).....    Y
 17. Stand-Alone Thermal Analyzer (ITAS-Format Models).....  N
 18. No. of Isolated Cavities (RADK files).....           0

================================================================================


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                          *ITAS THERMAL ANALYSIS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
********************************************************************************
Date: 05/20/94                                                Time: 14:38:44.10
********************************************************************************
================================================================================
                      View Factor Computation Parameters
================================================================================
1. View Factor Accuracy Parameter.....2
2. Engineering Units of the Geometry Data:
   1:inch, 2:feet, 3:centimeter, 4:meter.....1
3. View Factor Computation Without Blockage (Y/N).....N
4. Print Control Parameters:
   0:Do Not Print; 1:Print All; 2:Print All & Intervener List.0
5. View-Factor Re-Start File.....
================================================================================


/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
                        *ITAS VIEW FACTOR COMPUTATIONS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
 INPUT IS IN  INCHES
 OUTPUT IS IN CENTIMETERS
 TOTAL SURFACES IN THIS MODEL=   42


  UNITY MINUS THE SUM OF THE FACTORS
       (VIEW FACTOR -to- SPACE)

    SURFACE       1.-FACT      KEY

        1.01       0.3965   (   3)
        1.02       0.3648   (  25)
        1.03       0.3930   (  26)
        1.04       0.3858   (  27)
        1.05       0.3524   (  28)
        1.06       0.8752   (   1)
        1.07       0.3811   (   4)
        1.08       0.3527   (  29)
        1.09       0.3855   (  30)
        1.10       0.3854   (  31)
        1.11       0.3524   (  32)
        1.12      -0.0024   (   2)
        2.01       0.6859   (  42)
        2.02       0.8949   (  40)
        2.03       0.9450   (  37)
        2.04       0.9497   (  33)
        2.05       0.8709   (  20)
```

```
        2.06      0.5751    (  41)
        2.07      0.7484    (  39)
        2.08      0.7874    (  36)
        2.09      0.7810    (  22)
        2.10      0.7203    (  18)
        3.01      0.7066    (  23)
        3.02      0.8437    (  16)
        3.03      0.8486    (  15)
        3.04      0.7683    (  12)
        3.05      0.7970    (  21)
        3.06      0.9587    (  14)
        3.07      0.9678    (  13)
        3.08      0.8683    (  10)
        4.01     -0.0193    (   8)
        4.02     -0.0115    (   6)
        4.03     -0.0117    (  11)
        4.04     -0.0154    (  19)
        4.05     -0.0348    (  34)
        4.06     -0.0001    (  24)
        4.07     -0.0003    (  35)
        4.08      0.0000    (  38)
        4.09     -0.0171    (   7)
        4.10     -0.0116    (   5)
        4.11     -0.0118    (   9)
        4.12     -0.0112    (  17)
 ACTIVE SURFACES IN OUTPUT-   42
*************************************
 VIEW FACTOR CALC CPU TIME (second) =     34.7100
*************************************
 ** END OF PC-ITAS VIEW FACTOR CALCULATIONS **
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/
*******************************************************************************
Date: 05/20/94                                                Time: 14:39:19.10
*******************************************************************************
===============================================================================
                      Script-F Control Parameters
===============================================================================
1. SPACE (SINK) Node Number.....................................       0
2. Cutoff Limit For Area*Script-F (Sq.cm.)....................0.5000E+00
3. Cutoff Limit For Blackbody Viewfactors......................    0.0000
4. SPACE (SINK) Node Emissivity................................    0.9999
5. SPACE (SINK) Node Temperature (Kelvin)......................    0.0000
6. SINDA-format RADK file to be generated (Y/N)................         N
7. SINDA Radiation Conductor Number At Start...................    100000
8. Print control: 0:No,do not print, 1:Yes, print all.........         0
9. File name to store RADKs...................................EPS.RAD
===============================================================================
```

Seq	Surface No	Node No	Alpha	Emiss	T/Mass	Dissip	Matr ID
1	1.01	1	0.40	0.80	1.00	0.00	0
2	1.02	2	0.40	0.80	1.00	0.00	0
3	1.03	3	0.40	0.80	1.00	0.00	0
4	1.04	4	0.40	0.80	1.00	0.00	0
5	1.05	5	0.40	0.80	1.00	0.00	0
6	1.06	6	0.40	0.80	1.00	0.00	0
7	1.07	7	0.40	0.80	1.00	0.00	0

8	1.08	8	0.40	0.80	1.00	0.00	0
9	1.09	9	0.40	0.80	1.00	0.00	0
10	1.10	10	0.40	0.80	1.00	0.00	0
11	1.11	11	0.40	0.80	1.00	0.00	0
12	1.12	12	0.40	0.80	1.00	0.00	0
13	2.01	13	0.00	0.01	1.00	0.00	0
14	2.02	14	0.00	0.01	1.00	0.00	0
15	2.03	15	0.00	0.01	1.00	0.00	0
16	2.04	16	0.00	0.01	1.00	0.00	0
17	2.05	17	0.00	0.01	1.00	0.00	0
18	2.06	18	0.00	0.01	1.00	0.00	0
19	2.07	19	0.00	0.01	1.00	0.00	0
20	2.08	20	0.00	0.01	1.00	0.00	0
21	2.09	21	0.00	0.01	1.00	0.00	0
22	2.10	22	0.00	0.01	1.00	0.00	0
23	3.01	23	0.00	0.01	1.00	0.00	0
24	3.02	24	0.00	0.01	1.00	0.00	0
25	3.03	25	0.00	0.01	1.00	0.00	0
26	3.04	26	0.00	0.01	1.00	0.00	0
27	3.05	27	0.00	0.01	1.00	0.00	0
28	3.06	28	0.00	0.01	1.00	0.00	0
29	3.07	29	0.00	0.01	1.00	0.00	0
30	3.08	30	0.00	0.01	1.00	0.00	0
31	4.01	31	0.00	0.01	1.00	0.00	0
32	4.02	32	0.00	0.01	1.00	0.00	0
33	4.03	33	0.00	0.01	1.00	0.00	0
34	4.04	34	0.00	0.01	1.00	0.00	0
35	4.05	35	0.00	0.01	1.00	0.00	0
36	4.06	36	0.00	0.01	1.00	0.00	0
37	4.07	37	0.00	0.01	1.00	0.00	0
38	4.08	38	0.00	0.01	1.00	0.00	0
39	4.09	39	0.00	0.01	1.00	0.00	0
40	4.10	40	0.00	0.01	1.00	0.00	0
41	4.11	41	0.00	0.01	1.00	0.00	0
42	4.12	42	0.00	0.01	1.00	0.00	0

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ITAS SCRIPT-F (RADK) COMPUTATIONS

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PC-ITAS SCRIPT-F CALCULATION SEGMENT:
Writing ITAS-format RADK for future use

Node#,	Temp.,	TherMass,	Power	
1	10.00	1.00	0.00	EPS HOUSING
2	10.00	1.00	0.00	EPS HOUSING
3	10.00	1.00	0.00	EPS HOUSING
4	10.00	1.00	0.00	EPS HOUSING
5	10.00	1.00	0.00	EPS HOUSING
6	10.00	1.00	0.00	EPS HOUSING
7	10.00	1.00	0.00	EPS HOUSING
8	10.00	1.00	0.00	EPS HOUSING
9	10.00	1.00	0.00	EPS HOUSING
10	10.00	1.00	0.00	EPS HOUSING
11	10.00	1.00	0.00	EPS HOUSING
12	10.00	1.00	0.00	EPS HOUSING
13	10.00	1.00	0.00	PCB 1-1
14	10.00	1.00	0.00	PCB 1-1
15	10.00	1.00	0.00	PCB 1-1
16	10.00	1.00	0.00	PCB 1-1
17	10.00	1.00	0.00	PCB 1-1
18	10.00	1.00	0.00	PCB 1-1
19	10.00	1.00	0.00	PCB 1-1

20	10.00	1.00	0.00	PCB 1-1
21	10.00	1.00	0.00	PCB 1-1
22	10.00	1.00	0.00	PCB 1-1
23	10.00	1.00	0.00	PCB 1-2
24	10.00	1.00	0.00	PCB 1-2
25	10.00	1.00	0.00	PCB 1-2
26	10.00	1.00	0.00	PCB 1-2
27	10.00	1.00	0.00	PCB 1-2
28	10.00	1.00	0.00	PCB 1-2
29	10.00	1.00	0.00	PCB 1-2
30	10.00	1.00	0.00	PCB 1-2
31	10.00	1.00	0.00	PCB 2 (BOTTOM)
32	10.00	1.00	0.00	PCB 2 (BOTTOM)
33	10.00	1.00	0.00	PCB 2 (BOTTOM)
34	10.00	1.00	0.00	PCB 2 (BOTTOM)
35	10.00	1.00	0.00	PCB 2 (BOTTOM)
36	10.00	1.00	0.00	PCB 2 (BOTTOM)
37	10.00	1.00	0.00	PCB 2 (BOTTOM)
38	10.00	1.00	0.00	PCB 2 (BOTTOM)
39	10.00	1.00	0.00	PCB 2 (BOTTOM)
40	10.00	1.00	0.00	PCB 2 (BOTTOM)
41	10.00	1.00	0.00	PCB 2 (BOTTOM)
42	10.00	1.00	0.00	PCB 2 (BOTTOM)

RAD	00	0.1295000000E+01	1	4
RAD	00	0.3408000000E+01	1	5
RAD	00	0.1231900000E+02	1	6
RAD	00	0.1441000000E+01	1	7
RAD	00	0.1166000000E+01	1	10
RAD	00	0.3754000000E+01	1	11
RAD	00	0.9037000000E+01	1	12
RAD	00	0.5500000000E+00	2	3
RAD	00	0.3313000000E+01	2	6
RAD	00	0.3342000000E+01	2	7
RAD	00	0.2634000000E+01	2	12
RAD	00	0.9950000000E+00	3	4
RAD	00	0.3602000000E+01	3	6
RAD	00	0.9060000000E+00	3	7
RAD	00	0.2767000000E+01	3	12
RAD	00	0.7580000000E+00	4	5
RAD	00	0.3602000000E+01	4	6
RAD	00	0.2770000000E+01	4	12
RAD	00	0.3314000000E+01	5	6
RAD	00	0.2622000000E+01	5	12
RAD	00	0.1230000000E+02	6	7
RAD	00	0.3314000000E+01	6	8
RAD	00	0.3600000000E+01	6	9
RAD	00	0.3601000000E+01	6	10
RAD	00	0.3314000000E+01	6	11
RAD	00	0.1643000000E+01	6	12
RAD	00	0.3619000000E+01	7	8
RAD	00	0.1020000000E+01	7	9
RAD	00	0.9591000000E+01	7	12
RAD	00	0.7800000000E+00	8	9
RAD	00	0.2629000000E+01	8	12
RAD	00	0.7910000000E+00	9	10
RAD	00	0.2762000000E+01	9	12
RAD	00	0.2766000000E+01	10	12
RAD	00	0.2615000000E+01	11	12
RAD	00	0.5660000000E+00	12	32
RAD	00	0.5110000000E+00	12	39

```
RAD      00     0.6110000000E+00          12          40

 #OF RADIATION CONDUCTANCES GENERATED=    38
************************************
 SCRIPT-F CALC CPU TIME (second)     =     2.58000
************************************
 ITAS THERMAL ANALYZER:
vvvvvvvvvvvvvvvvvvv ADDING USER NODES vvvvvvvvvvv
IPTR_N= 5022
RECORD  5022=    1     901    20            0      EPS HOUSING WALLS +X
RECORD  5023=    2     902    20            0      +Y
RECORD  5024=    3     903    20            0      +Y
RECORD  5025=    4     904    20            0      +Y
RECORD  5026=    5     905    20            0      +Y
RECORD  5027=    6     906    20            0      +Z
RECORD  5028=    7     907    20            0      -X
RECORD  5029=    8     908    20            0      -Y
RECORD  5030=    9     909    20            0      -Y
RECORD  5031=   10     910    20            0      -Y
RECORD  5032=   11     911    20            0      -Y
RECORD  5033=   12     912    20            0      -Z
RECORD  5034=   13     -913   0             0      BOUNDARY NODE TO 906
RECORD  5035=   14     921    20            0      HOUSING +Y BOTTOM RAIL
RECORD  5036=   15     922    20            0      +Y MIDDLE RAIL
RECORD  5037=   16     923    20            0      +Y TOP RAIL
RECORD  5038=   17     924    20            0      -Y BOTTOM RAIL
RECORD  5039=   18     925    20            0      -Y MIDDLE RAIL
RECORD  5040=   19     926    20            0      -Y TOP RAIL
RECORD  5041=   20     601    20           .058    TOP PCB THERMAL PLANE
RECORD  5042=   21     602    20           .070
RECORD  5043=   22     603    20           .026
RECORD  5044=   23     604    20           .001
RECORD  5045=   24     605    20            0
RECORD  5046=   25     606    20            0
RECORD  5047=   26     607    20            0
RECORD  5048=   27     608    20            0
RECORD  5049=   28     609    20            0
RECORD  5050=   29     610    20            0
RECORD  5051=   30     611    20            0
RECORD  5052=   31     612    20            0
RECORD  5053=   32     613    20            0
RECORD  5054=   33     614    20            0
RECORD  5055=   34     615    20            0
RECORD  5056=   35     616    20            0
RECORD  5057=   36     617    20            0
RECORD  5058=   37     618    20            0
RECORD  5059=   38     501    20            0      5TH LAYER POLYIMIDE
RECORD  5060=   39     502    20            0
RECORD  5061=   40     503    20            0
RECORD  5062=   41     504    20            0
RECORD  5063=   42     505    20            0
RECORD  5064=   43     506    20            0
RECORD  5065=   44     507    20            0
RECORD  5066=   45     508    20            0
RECORD  5067=   46     509    20            0
RECORD  5068=   47     510    20            0
RECORD  5069=   48     511    20            0
RECORD  5070=   49     512    20            0
RECORD  5071=   50     513    20            0
RECORD  5072=   51     514    20            0
```

```
RECORD  5073=   52    515   20          0
RECORD  5074=   53    516   20          0
RECORD  5075=   54    517   20          0
RECORD  5076=   55    518   20
RECORD  5077=   56    401   20          .003  GROUND LAYER  COPPER
RECORD  5078=   57    402   20          .004
RECORD  5079=   58    403   20          .001
RECORD  5080=   59    404   20          .001
RECORD  5081=   60    405   20          0
RECORD  5082=   61    406   20          0
RECORD  5083=   62    407   20          0
RECORD  5084=   63    408   20          0
RECORD  5085=   64    409   20          0
RECORD  5086=   65    410   20          0
RECORD  5087=   66    411   20          0
RECORD  5088=   67    412   20          0
RECORD  5089=   68    413   20          0
RECORD  5090=   69    414   20          0
RECORD  5091=   70    415   20          0
RECORD  5092=   71    416   20          0
RECORD  5093=   72    417   20          0
RECORD  5094=   73    418   20          0
RECORD  5095=   74    301   20          0     3RD LAYER POLYIMIDE
RECORD  5096=   75    302   20          0
RECORD  5097=   76    303   20          0
RECORD  5098=   77    304   20          0
RECORD  5099=   78    305   20          0
RECORD  5100=   79    306   20          0
RECORD  5101=   80    307   20          0
RECORD  5102=   81    308   20          0
RECORD  5103=   82    309   20          0
RECORD  5104=   83    310   20          0
RECORD  5105=   84    311   20          0
RECORD  5106=   85    312   20          0
RECORD  5107=   86    313   20          0
RECORD  5108=   87    314   20          0
RECORD  5109=   88    315   20          0
RECORD  5110=   89    316   20          0
RECORD  5111=   90    317   20          0
RECORD  5112=   91    318   20          0
RECORD  5113=   92    201   20          0     SIGNAL LEVEL (VERY LITTLE CU)
RECORD  5114=   93    202   20          0
RECORD  5115=   94    203   20          0
RECORD  5116=   95    204   20          0
RECORD  5117=   96    205   20          0
RECORD  5118=   97    206   20          0
RECORD  5119=   98    207   20          0
RECORD  5120=   99    208   20          0
RECORD  5121=  100    209   20          0
RECORD  5122=  101    210   20          0
RECORD  5123=  102    211   20          0
RECORD  5124=  103    212   20          0
RECORD  5125=  104    213   20          0
RECORD  5126=  105    214   20          0
RECORD  5127=  106    215   20          0
RECORD  5128=  107    216   20          0
RECORD  5129=  108    217   20          0
RECORD  5130=  109    218   20          0
RECORD  5131=  110    101   20          0     TOP LAYER POLYIMIDE
RECORD  5132=  111    102   20          0
```

RECORD	5133=	112	103	20	0	
RECORD	5134=	113	104	20	0	
RECORD	5135=	114	105	20	0	
RECORD	5136=	115	106	20	0	
RECORD	5137=	116	107	20	0	
RECORD	5138=	117	108	20	0	
RECORD	5139=	118	109	20	0	
RECORD	5140=	119	110	20	0	
RECORD	5141=	120	111	20	0	
RECORD	5142=	121	112	20	0	
RECORD	5143=	122	113	20	0	
RECORD	5144=	123	114	20	0	
RECORD	5145=	124	115	20	0	
RECORD	5146=	125	116	20	0	
RECORD	5147=	126	117	20	0	
RECORD	5148=	127	118	20	0	
RECORD	5149=	128	1601	20	0	BOTTOM PCB THERMAL PLANE COPPER
RECORD	5150=	129	1602	20	0	
RECORD	5151=	130	1603	20	0	
RECORD	5152=	131	1604	20	0	
RECORD	5153=	132	1605	20	0	
RECORD	5154=	133	1606	20	0	
RECORD	5155=	134	1607	20	0	
RECORD	5156=	135	1608	20	0	
RECORD	5157=	136	1609	20	0	
RECORD	5158=	137	1610	20	0	
RECORD	5159=	138	1611	20	0	
RECORD	5160=	139	1612	20	0	
RECORD	5161=	140	1613	20	0	
RECORD	5162=	141	1614	20	0	
RECORD	5163=	142	1615	20	0	
RECORD	5164=	143	1616	20	0	
RECORD	5165=	144	1617	20	0	
RECORD	5166=	145	1618	20	0	
RECORD	5167=	146	1501	20	0	5TH LAYER POLYIMIDE
RECORD	5168=	147	1502	20	0	
RECORD	5169=	148	1503	20	0	
RECORD	5170=	149	1504	20	0	
RECORD	5171=	150	1505	20	0	
RECORD	5172=	151	1506	20	0	
RECORD	5173=	152	1507	20	0	
RECORD	5174=	153	1508	20	0	
RECORD	5175=	154	1509	20	0	
RECORD	5176=	155	1510	20	0	
RECORD	5177=	156	1511	20	0	
RECORD	5178=	157	1512	20	0	
RECORD	5179=	158	1513	20	0	
RECORD	5180=	159	1514	20	0	
RECORD	5181=	160	1515	20	0	
RECORD	5182=	161	1516	20	0	
RECORD	5183=	162	1517	20	0	
RECORD	5184=	163	1518	20	0	
RECORD	5185=	164	1401	20	0	GROUND LAYER COPPER
RECORD	5186=	165	1402	20	0	
RECORD	5187=	166	1403	20	0	
RECORD	5188=	167	1404	20	0	
RECORD	5189=	168	1405	20	0	
RECORD	5190=	169	1406	20	0	
RECORD	5191=	170	1407	20	0	
RECORD	5192=	171	1408	20	0	

RECORD	5193= 172	1409	20	0	
RECORD	5194= 173	1410	20	0	
RECORD	5195= 174	1411	20	0	
RECORD	5196= 175	1412	20	0	
RECORD	5197= 176	1413	20	0	
RECORD	5198= 177	1414	20	0	
RECORD	5199= 178	1415	20	0	
RECORD	5200= 179	1416	20	0	
RECORD	5201= 180	1417	20	0	
RECORD	5202= 181	1418	20	0	
RECORD	5203= 182	1301	20	0	3RD LAYER POLYIMIDE
RECORD	5204= 183	1302	20	0	
RECORD	5205= 184	1303	20	0	
RECORD	5206= 185	1304	20	0	
RECORD	5207= 186	1305	20	0	
RECORD	5208= 187	1306	20	0	
RECORD	5209= 188	1307	20	0	
RECORD	5210= 189	1308	20	0	
RECORD	5211= 190	1309	20	0	
RECORD	5212= 191	1310	20	0	
RECORD	5213= 192	1311	20	0	
RECORD	5214= 193	1312	20	0	
RECORD	5215= 194	1313	20	0	
RECORD	5216= 195	1314	20	0	
RECORD	5217= 196	1315	20	0	
RECORD	5218= 197	1316	20	0	
RECORD	5219= 198	1317	20	0	
RECORD	5220= 199	1318	20	0	
RECORD	5221= 200	1201	20	0	SIGNAL LAYER COPPER
RECORD	5222= 201	1202	20	0	
RECORD	5223= 202	1203	20	0	
RECORD	5224= 203	1204	20	0	
RECORD	5225= 204	1205	20	0	
RECORD	5226= 205	1206	20	0	
RECORD	5227= 206	1207	20	0	
RECORD	5228= 207	1208	20	0	
RECORD	5229= 208	1209	20	0	
RECORD	5230= 209	1210	20	0	
RECORD	5231= 210	1211	20	0	
RECORD	5232= 211	1212	20	0	
RECORD	5233= 212	1213	20	0	
RECORD	5234= 213	1214	20	0	
RECORD	5235= 214	1215	20	0	
RECORD	5236= 215	1216	20	0	
RECORD	5237= 216	1217	20	0	
RECORD	5238= 217	1218	20	0	
RECORD	5239= 218	1101	20	0	TOP LAYER POLYIMIDE
RECORD	5240= 219	1102	20	0	
RECORD	5241= 220	1103	20	0	
RECORD	5242= 221	1104	20	0	
RECORD	5243= 222	1105	20	0	
RECORD	5244= 223	1106	20	0	
RECORD	5245= 224	1107	20	0	
RECORD	5246= 225	1108	20	0	
RECORD	5247= 226	1109	20	0	
RECORD	5248= 227	1110	20	0	
RECORD	5249= 228	1111	20	0	
RECORD	5250= 229	1112	20	0	
RECORD	5251= 230	1113	20	0	
RECORD	5252= 231	1114	20	0	

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RECORD  5253= 232    1115  20          0
RECORD  5254= 233    1116  20          0
RECORD  5255= 234    1117  20          0
RECORD  5256= 235    1118  20          0
^^^^^^^^^^^^^^^^^^^^ END OF USER NODES ^^^^^^^^^^
^^^^^^^^^^^^^^^^^^^^ END OF FLUID ^^^^^^^^^^^^^^^^
 TOTAL THERMAL MASS ENCOUNTERED (W-MIN/C)=    1329.04
 TOTAL THERMAL MASS ENCOUNTERED (BTU  /F)=    42.0002
^^^^^^^^^^^^^^^^^^^^ END OF FLUID ^^^^^^^^^^^^^^^^^^
 NODE      1 (REL NODE      1 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      2 (REL NODE      2 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      3 (REL NODE      3 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      4 (REL NODE      4 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      5 (REL NODE      5 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      6 (REL NODE      6 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      7 (REL NODE      7 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      8 (REL NODE      8 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      9 (REL NODE      9 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     10 (REL NODE     10 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     11 (REL NODE     11 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     12 (REL NODE     12 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     13 (REL NODE     13 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     14 (REL NODE     14 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     15 (REL NODE     15 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     16 (REL NODE     16 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     17 (REL NODE     17 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     18 (REL NODE     18 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     19 (REL NODE     19 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     20 (REL NODE     20 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     21 (REL NODE     21 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     22 (REL NODE     22 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     23 (REL NODE     23 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     24 (REL NODE     24 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     25 (REL NODE     25 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     26 (REL NODE     26 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     27 (REL NODE     27 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     28 (REL NODE     28 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     29 (REL NODE     29 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     30 (REL NODE     30 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     31 (REL NODE     31 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     32 (REL NODE     32 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     33 (REL NODE     33 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     34 (REL NODE     34 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     35 (REL NODE     35 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     36 (REL NODE     36 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     37 (REL NODE     37 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     38 (REL NODE     38 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     39 (REL NODE     39 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     40 (REL NODE     40 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     41 (REL NODE     41 ) IS BEING ADDED TO THE CURRENT LIST
 NODE     42 (REL NODE     42 ) IS BEING ADDED TO THE CURRENT LIST
 END OF RADIATION CONDUCTANCE & POWER PROCESSING
 ITAS THERMAL ANALYSIS:


 CHECKOUT PHASE OF PC-ITAS THERMAL ANALYSIS

 TOTAL CARDS ENCOUNTERED:   1760
 TOTAL THERMAL MASSES USED (W-MIN/C)=    1366.04
 TOTAL THERMAL MASSES USED (BTU/F  )=    43.1695
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NO. OF THERMAL NODES= 277

ITAS STEADY-STATE SOLUTION ALGORITHM (SUCCESSIVE POINT ITERATION) PARAMETERS:
ARLXCA=0.10000E-02, DRLXCA=0.10000E-02 NLOOP= 9999

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ITAS STEADY-STATE SOLUTION (SUCCESSIVE POINT ITERATION)
NO. OF ITERATIONS= 2588 TOTAL INPUT ENERGY (W)= 0.16400
SYSTEM ENERGY BALANCE (W)= -8.0523 (4909.9 %)

****

T	1=	0.43	T	2=	0.80	T	3=	0.83	T	4=	0.83
T	5=	0.77	T	6=	0.12	T	7=	0.56	T	8=	0.44
T	9=	0.44	T	10=	0.44	T	11=	0.44	T	12=	0.51
T	13=	19.79	T	14=	19.59	T	15=	19.39	T	16=	19.33
T	17=	18.55	T	18=	3.13	T	19=	2.51	T	20=	1.55
T	21=	0.87	T	22=	0.97	T	23=	1.38	T	24=	1.03
T	25=	0.97	T	26=	0.75	T	27=	19.60	T	28=	19.24
T	29=	19.25	T	30=	19.27	T	31=	0.88	T	32=	0.86
T	33=	0.97	T	34=	1.30	T	35=	18.46	T	36=	18.33
T	37=	18.87	T	38=	19.28	T	39=	0.88	T	40=	0.86
T	41=	0.96	T	42=	1.26	T	901=	0.43	T	902=	0.80
T	903=	0.83	T	904=	0.83	T	905=	0.77	T	906=	0.12
T	907=	0.56	T	908=	0.44	T	909=	0.44	T	910=	0.44
T	911=	0.44	T	912=	0.51	T	913=	0.00	T	921=	0.50
T	922=	0.47	T	923=	0.36	T	924=	0.50	T	925=	0.46
T	926=	0.36	T	601=	1.38	T	602=	1.03	T	603=	0.97
T	604=	0.75	T	605=	19.60	T	606=	19.24	T	607=	19.25
T	608=	19.26	T	609=	19.79	T	610=	19.59	T	611=	19.39
T	612=	19.33	T	613=	18.55	T	614=	3.13	T	615=	2.51
T	616=	1.54	T	617=	0.87	T	618=	0.97	T	501=	4.19
T	502=	3.89	T	503=	3.62	T	504=	3.19	T	505=	15.90
T	506=	15.62	T	507=	15.37	T	508=	14.53	T	509=	15.54
T	510=	15.32	T	511=	15.20	T	512=	15.29	T	513=	14.24
T	514=	5.94	T	515=	5.68	T	516=	5.08	T	517=	4.29
T	518=	4.44	T	401=	6.91	T	402=	6.69	T	403=	6.21
T	404=	5.58	T	405=	12.30	T	406=	12.05	T	407=	11.54
T	408=	9.94	T	409=	11.44	T	410=	11.26	T	411=	11.16
T	412=	11.34	T	413=	10.08	T	414=	8.62	T	415=	8.66
T	416=	8.47	T	417=	7.62	T	418=	7.77	T	301=	6.31
T	302=	6.10	T	303=	5.67	T	304=	4.99	T	305=	12.30
T	306=	12.06	T	307=	11.54	T	308=	9.94	T	309=	11.44
T	310=	11.26	T	311=	11.17	T	312=	11.34	T	313=	10.08
T	314=	7.52	T	315=	7.50	T	316=	7.42	T	317=	6.66
T	318=	6.78	T	201=	5.70	T	202=	5.51	T	203=	5.13
T	204=	4.39	T	205=	12.30	T	206=	12.06	T	207=	11.54
T	208=	9.94	T	209=	11.44	T	210=	11.26	T	211=	11.17
T	212=	11.34	T	213=	10.07	T	214=	6.42	T	215=	6.34
T	216=	6.36	T	217=	5.70	T	218=	5.79	T	101=	5.10
T	102=	4.93	T	103=	4.59	T	104=	3.80	T	105=	12.30
T	106=	12.06	T	107=	11.54	T	108=	9.94	T	109=	11.44
T	110=	11.26	T	111=	11.17	T	112=	11.34	T	113=	10.07
T	114=	5.32	T	115=	5.95	T	116=	5.31	T	117=	4.74
T	118=	4.80	T	1601=	0.88	T	1602=	0.86	T	1603=	0.97
T	1604=	1.30	T	1605=	18.46	T	1606=	18.33	T	1607=	18.87
T	1608=	19.28	T	1609=	0.88	T	1610=	0.86	T	1611=	0.96
T	1612=	1.26	T	1613=	20.00	T	1614=	20.00	T	1615=	20.00
T	1616=	20.00	T	1617=	20.00	T	1618=	20.00	T	1501=	1.90
T	1502=	1.90	T	1503=	2.00	T	1504=	2.22	T	1505=	11.83
T	1506=	11.79	T	1507=	12.10	T	1508=	12.28	T	1509=	1.97
T	1510=	1.97	T	1511=	2.07	T	1512=	2.27	T	1513=	20.00

T	1514=	20.00	T	1515=	20.00	T	1516=	20.00	T	1517=	20.00
T	1518=	20.00	T	1401=	2.89	T	1402=	2.91	T	1403=	3.00
T	1404=	3.08	T	1405=	5.39	T	1406=	5.41	T	1407=	5.55
T	1408=	5.63	T	1409=	3.03	T	1410=	3.05	T	1411=	3.14
T	1412=	3.22	T	1413=	20.00	T	1414=	20.00	T	1415=	20.00
T	1416=	20.00	T	1417=	20.00	T	1418=	20.00	T	1301=	2.72
T	1302=	2.74	T	1303=	2.82	T	1304=	2.90	T	1305=	5.39
T	1306=	5.41	T	1307=	5.55	T	1308=	5.63	T	1309=	2.83
T	1310=	2.85	T	1311=	2.94	T	1312=	3.02	T	1313=	20.00
T	1314=	20.00	T	1315=	20.00	T	1316=	20.00	T	1317=	20.00
T	1318=	20.00	T	1201=	2.54	T	1202=	2.56	T	1203=	2.64
T	1204=	2.72	T	1205=	5.39	T	1206=	5.41	T	1207=	5.55
T	1208=	5.63	T	1209=	2.64	T	1210=	2.66	T	1211=	2.74
T	1212=	2.82	T	1213=	20.00	T	1214=	20.00	T	1215=	20.00
T	1216=	20.00	T	1217=	20.00	T	1218=	20.00	T	1101=	2.37
T	1102=	2.38	T	1103=	2.46	T	1104=	2.54	T	1105=	5.39
T	1106=	5.41	T	1107=	5.55	T	1108=	5.63	T	1109=	2.44
T	1110=	2.46	T	1111=	2.54	T	1112=	2.62	T	1113=	20.00
T	1114=	20.00	T	1115=	20.00	T	1116=	20.00	T	1117=	20.00
T	1118=	20.00	T								

ASCENDING NODE NUMBER : TEMPERATURE

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ITAS STEADY-STATE SOLUTION (SUCCESSIVE POINT ITERATION)
NO. OF ITERATIONS= 2588 TOTAL INPUT ENERGY (W)= 0.16400
SYSTEM ENERGY BALANCE (W)= -8.0523 (4909.9 %)

****

T	1=	0.433	T	2=	0.796	T	3=	0.832	T	4=	0.832
T	5=	0.770	T	6=	0.124	T	7=	0.563	T	8=	0.438
T	9=	0.437	T	10=	0.437	T	11=	0.438	T	12=	0.508
T	13=	19.791	T	14=	19.587	T	15=	19.386	T	16=	19.329
T	17=	18.549	T	18=	3.130	T	19=	2.511	T	20=	1.545
T	21=	0.869	T	22=	0.968	T	23=	1.381	T	24=	1.030
T	25=	0.969	T	26=	0.754	T	27=	19.596	T	28=	19.236
T	29=	19.254	T	30=	19.265	T	31=	0.876	T	32=	0.858
T	33=	0.966	T	34=	1.298	T	35=	18.463	T	36=	18.326
T	37=	18.872	T	38=	19.277	T	39=	0.885	T	40=	0.858
T	41=	0.958	T	42=	1.260	T	101=	5.103	T	102=	4.925
T	103=	4.595	T	104=	3.798	T	105=	12.301	T	106=	12.056
T	107=	11.542	T	108=	9.940	T	109=	11.437	T	110=	11.260
T	111=	11.166	T	112=	11.344	T	113=	10.075	T	114=	5.318
T	115=	5.949	T	116=	5.314	T	117=	4.742	T	118=	4.804
T	201=	5.705	T	202=	5.513	T	203=	5.134	T	204=	4.393
T	205=	12.301	T	206=	12.056	T	207=	11.542	T	208=	9.940
T	209=	11.437	T	210=	11.260	T	211=	11.166	T	212=	11.344
T	213=	10.075	T	214=	6.419	T	215=	6.337	T	216=	6.365
T	217=	5.700	T	218=	5.795	T	301=	6.307	T	302=	6.100
T	303=	5.674	T	304=	4.989	T	305=	12.301	T	306=	12.055
T	307=	11.542	T	308=	9.939	T	309=	11.438	T	310=	11.260
T	311=	11.165	T	312=	11.344	T	313=	10.075	T	314=	7.521
T	315=	7.501	T	316=	7.415	T	317=	6.658	T	318=	6.785
T	401=	6.908	T	402=	6.687	T	403=	6.213	T	404=	5.584
T	405=	12.301	T	406=	12.055	T	407=	11.542	T	408=	9.939
T	409=	11.438	T	410=	11.260	T	411=	11.165	T	412=	11.344
T	413=	10.075	T	414=	8.622	T	415=	8.664	T	416=	8.465
T	417=	7.615	T	418=	7.775	T	501=	4.190	T	502=	3.888
T	503=	3.620	T	504=	3.195	T	505=	15.904	T	506=	15.618
T	507=	15.370	T	508=	14.526	T	509=	15.540	T	510=	15.318
T	511=	15.195	T	512=	15.285	T	513=	14.240	T	514=	5.939
T	515=	5.684	T	516=	5.080	T	517=	4.288	T	518=	4.443

T	601=	1.381	T	602=	1.030	T	603=	0.969	T	604=	0.754
T	605=	19.596	T	606=	19.235	T	607=	19.254	T	608=	19.265
T	609=	19.791	T	610=	19.587	T	611=	19.386	T	612=	19.328
T	613=	18.549	T	614=	3.129	T	615=	2.510	T	616=	1.545
T	617=	0.868	T	618=	0.968	T	901=	0.432	T	902=	0.796
T	903=	0.832	T	904=	0.831	T	905=	0.769	T	906=	0.124
T	907=	0.562	T	908=	0.438	T	909=	0.437	T	910=	0.437
T	911=	0.437	T	912=	0.508	T	913=	0.000	T	921=	0.501
T	922=	0.474	T	923=	0.362	T	924=	0.501	T	925=	0.460
T	926=	0.362	T	1101=	2.367	T	1102=	2.385	T	1103=	2.463
T	1104=	2.544	T	1105=	5.390	T	1106=	5.409	T	1107=	5.550
T	1108=	5.629	T	1109=	2.444	T	1110=	2.462	T	1111=	2.539
T	1112=	2.620	T	1113=	20.000	T	1114=	20.000	T	1115=	20.000
T	1116=	20.000	T	1117=	20.000	T	1118=	20.000	T	1201=	2.542
T	1202=	2.561	T	1203=	2.644	T	1204=	2.724	T	1205=	5.390
T	1206=	5.409	T	1207=	5.550	T	1208=	5.629	T	1209=	2.638
T	1210=	2.657	T	1211=	2.740	T	1212=	2.820	T	1213=	20.000
T	1214=	20.000	T	1215=	20.000	T	1216=	20.000	T	1217=	20.000
T	1218=	20.000	T	1301=	2.716	T	1302=	2.736	T	1303=	2.824
T	1304=	2.904	T	1305=	5.390	T	1306=	5.409	T	1307=	5.549
T	1308=	5.629	T	1309=	2.832	T	1310=	2.853	T	1311=	2.940
T	1312=	3.020	T	1313=	20.000	T	1314=	20.000	T	1315=	20.000
T	1316=	20.000	T	1317=	20.000	T	1318=	20.000	T	1401=	2.890
T	1402=	2.912	T	1403=	3.004	T	1404=	3.083	T	1405=	5.389
T	1406=	5.410	T	1407=	5.549	T	1408=	5.628	T	1409=	3.025
T	1410=	3.048	T	1411=	3.140	T	1412=	3.220	T	1413=	20.000
T	1414=	20.000	T	1415=	20.000	T	1416=	20.000	T	1417=	20.000
T	1418=	20.000	T	1501=	1.900	T	1502=	1.900	T	1503=	2.004
T	1504=	2.221	T	1505=	11.831	T	1506=	11.788	T	1507=	12.104
T	1508=	12.278	T	1509=	1.973	T	1510=	1.969	T	1511=	2.070
T	1512=	2.272	T	1513=	20.000	T	1514=	20.000	T	1515=	20.000
T	1516=	20.000	T	1517=	20.000	T	1518=	20.000	T	1601=	0.875
T	1602=	0.858	T	1603=	0.965	T	1604=	1.298	T	1605=	18.463
T	1606=	18.325	T	1607=	18.871	T	1608=	19.277	T	1609=	0.884
T	1610=	0.858	T	1611=	0.958	T	1612=	1.260	T	1613=	20.000
T	1614=	20.000	T	1615=	20.000	T	1616=	20.000	T	1617=	20.000
T	1618=	20.000	T								

ASCENDING NODE NUMBER : IMPRESSED Q

Q	1=	0.000	Q	2=	0.000	Q	3=	0.000	Q	4=	0.000
Q	5=	0.000	Q	6=	0.000	Q	7=	0.000	Q	8=	0.000
Q	9=	0.000	Q	10=	0.000	Q	11=	0.000	Q	12=	0.000
Q	13=	0.000	Q	14=	0.000	Q	15=	0.000	Q	16=	0.000
Q	17=	0.000	Q	18=	0.000	Q	19=	0.000	Q	20=	0.000
Q	21=	0.000	Q	22=	0.000	Q	23=	0.000	Q	24=	0.000
Q	25=	0.000	Q	26=	0.000	Q	27=	0.000	Q	28=	0.000
Q	29=	0.000	Q	30=	0.000	Q	31=	0.000	Q	32=	0.000
Q	33=	0.000	Q	34=	0.000	Q	35=	0.000	Q	36=	0.000
Q	37=	0.000	Q	38=	0.000	Q	39=	0.000	Q	40=	0.000
Q	41=	0.000	Q	42=	0.000	Q	101=	0.000	Q	102=	0.000
Q	103=	0.000	Q	104=	0.000	Q	105=	0.000	Q	106=	0.000
Q	107=	0.000	Q	108=	0.000	Q	109=	0.000	Q	110=	0.000
Q	111=	0.000	Q	112=	0.000	Q	113=	0.000	Q	114=	0.000
Q	115=	0.000	Q	116=	0.000	Q	117=	0.000	Q	118=	0.000
Q	201=	0.000	Q	202=	0.000	Q	203=	0.000	Q	204=	0.000
Q	205=	0.000	Q	206=	0.000	Q	207=	0.000	Q	208=	0.000
Q	209=	0.000	Q	210=	0.000	Q	211=	0.000	Q	212=	0.000
Q	213=	0.000	Q	214=	0.000	Q	215=	0.000	Q	216=	0.000
Q	217=	0.000	Q	218=	0.000	Q	301=	0.000	Q	302=	0.000
Q	303=	0.000	Q	304=	0.000	Q	305=	0.000	Q	306=	0.000
Q	307=	0.000	Q	308=	0.000	Q	309=	0.000	Q	310=	0.000

```
Q    311=      0.000 Q    312=      0.000 Q    313=      0.000 Q    314=      0.000
Q    315=      0.000 Q    316=      0.000 Q    317=      0.000 Q    318=      0.000
Q    401=      0.003 Q    402=      0.004 Q    403=      0.001 Q    404=      0.001
Q    405=      0.000 Q    406=      0.000 Q    407=      0.000 Q    408=      0.000
Q    409=      0.000 Q    410=      0.000 Q    411=      0.000 Q    412=      0.000
Q    413=      0.000 Q    414=      0.000 Q    415=      0.000 Q    416=      0.000
Q    417=      0.000 Q    418=      0.000 Q    501=      0.000 Q    502=      0.000
Q    503=      0.000 Q    504=      0.000 Q    505=      0.000 Q    506=      0.000
Q    507=      0.000 Q    508=      0.000 Q    509=      0.000 Q    510=      0.000
Q    511=      0.000 Q    512=      0.000 Q    513=      0.000 Q    514=      0.000
Q    515=      0.000 Q    516=      0.000 Q    517=      0.000 Q    518=      0.000
Q    601=      0.058 Q    602=      0.070 Q    603=      0.026 Q    604=      0.001
Q    605=      0.000 Q    606=      0.000 Q    607=      0.000 Q    608=      0.000
Q    609=      0.000 Q    610=      0.000 Q    611=      0.000 Q    612=      0.000
Q    613=      0.000 Q    614=      0.000 Q    615=      0.000 Q    616=      0.000
Q    617=      0.000 Q    618=      0.000 Q    901=      0.000 Q    902=      0.000
Q    903=      0.000 Q    904=      0.000 Q    905=      0.000 Q    906=      0.000
Q    907=      0.000 Q    908=      0.000 Q    909=      0.000 Q    910=      0.000
Q    911=      0.000 Q    912=      0.000 Q    913=      0.000 Q    921=      0.000
Q    922=      0.000 Q    923=      0.000 Q    924=      0.000 Q    925=      0.000
Q    926=      0.000 Q   1101=      0.000 Q   1102=      0.000 Q   1103=      0.000
Q   1104=      0.000 Q   1105=      0.000 Q   1106=      0.000 Q   1107=      0.000
Q   1108=      0.000 Q   1109=      0.000 Q   1110=      0.000 Q   1111=      0.000
Q   1112=      0.000 Q   1113=      0.000 Q   1114=      0.000 Q   1115=      0.000
Q   1116=      0.000 Q   1117=      0.000 Q   1118=      0.000 Q   1201=      0.000
Q   1202=      0.000 Q   1203=      0.000 Q   1204=      0.000 Q   1205=      0.000
Q   1206=      0.000 Q   1207=      0.000 Q   1208=      0.000 Q   1209=      0.000
Q   1210=      0.000 Q   1211=      0.000 Q   1212=      0.000 Q   1213=      0.000
Q   1214=      0.000 Q   1215=      0.000 Q   1216=      0.000 Q   1217=      0.000
Q   1218=      0.000 Q   1301=      0.000 Q   1302=      0.000 Q   1303=      0.000
Q   1304=      0.000 Q   1305=      0.000 Q   1306=      0.000 Q   1307=      0.000
Q   1308=      0.000 Q   1309=      0.000 Q   1310=      0.000 Q   1311=      0.000
Q   1312=      0.000 Q   1313=      0.000 Q   1314=      0.000 Q   1315=      0.000
Q   1316=      0.000 Q   1317=      0.000 Q   1318=      0.000 Q   1401=      0.000
Q   1402=      0.000 Q   1403=      0.000 Q   1404=      0.000 Q   1405=      0.000
Q   1406=      0.000 Q   1407=      0.000 Q   1408=      0.000 Q   1409=      0.000
Q   1410=      0.000 Q   1411=      0.000 Q   1412=      0.000 Q   1413=      0.000
Q   1414=      0.000 Q   1415=      0.000 Q   1416=      0.000 Q   1417=      0.000
Q   1418=      0.000 Q   1501=      0.000 Q   1502=      0.000 Q   1503=      0.000
Q   1504=      0.000 Q   1505=      0.000 Q   1506=      0.000 Q   1507=      0.000
Q   1508=      0.000 Q   1509=      0.000 Q   1510=      0.000 Q   1511=      0.000
Q   1512=      0.000 Q   1513=      0.000 Q   1514=      0.000 Q   1515=      0.000
Q   1516=      0.000 Q   1517=      0.000 Q   1518=      0.000 Q   1601=      0.000
Q   1602=      0.000 Q   1603=      0.000 Q   1604=      0.000 Q   1605=      0.000
Q   1606=      0.000 Q   1607=      0.000 Q   1608=      0.000 Q   1609=      0.000
Q   1610=      0.000 Q   1611=      0.000 Q   1612=      0.000 Q   1613=      0.000
Q   1614=      0.000 Q   1615=      0.000 Q   1616=      0.000 Q   1617=      0.000
Q   1618=      0.000 Q
**************************************
 THERMAL CALC CPU TIME (second)      =     98.8100
**************************************
```

APPENDIX I ITAS OUTPUT FOR HOT-CASE

```
**********************************************************************************
Date: 05/20/94                                                  Time: 15:04:24.10
**********************************************************************************
==================================================================================
                        Thermal Analysis Parameters
==================================================================================
 1.  Solution Method:1.Steady-State 2.Transient 3. (1&2).....          1
 2.  Solution Time Step .....(minutes).....                         0.10
 3.  Final Time (minutes);if <0 then no of orbs.....                -1.00
 4.  Starting Temperature .....(Kelvin ).....                      300.00
 5.  Temperature Print Interval (minutes).....                      20
 6.  No. of Iterations For Convergence (NLOOP).....                 9999
 7.  Temperature Unit 1:K, 2:C, 3:F, 4:R.....                       2
 8.  Solution Accuracy Parameter (not used).....                    130
 9.  Solution Convergence Parameter (not used).....                 1.30
 10. Solution Tolerance (ARLXCA, DRLXCA).....                    0.00100
 11. Transient Solution Stability Factor (not used).....            0.850
 12. Include User-Defined Network.....(Y/N).....                    Y
 13. Print RADK, POWER.....(Y/N).....                               N
 14. Print Transient Time/Temperature...(Y/N).....                  N
 15. Starting Temperatures Forced (No.4)(Y/N).....                  N
 16. Thermal Analyses Without Orbital Loads (Y/N).....              Y
 17. Stand-Alone Thermal Analyzer (ITAS-Format Models).....         N
 18. No. of Isolated Cavities (RADK files).....                     0

==================================================================================

/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
                          *ITAS THERMAL ANALYSIS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
**********************************************************************************
Date: 05/20/94                                                  Time: 15:04:24.10
**********************************************************************************
==================================================================================
                      View Factor Computation Parameters
==================================================================================
1. View Factor Accuracy Parameter.....2
2. Engineering Units of the Geometry Data:
   1:inch, 2:feet, 3:centimeter, 4:meter.....1
3. View Factor Computation Without Blockage (Y/N).....N
4. Print Control Parameters:
   0:Do Not Print; 1:Print All; 2:Print All & Intervener List.0
5. View-Factor Re-Start File.....
==================================================================================

/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
                        *ITAS VIEW FACTOR COMPUTATIONS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
 INPUT IS IN  INCHES
 OUTPUT IS IN CENTIMETERS
 TOTAL SURFACES IN THIS MODEL=    42


  UNITY MINUS THE SUM OF THE FACTORS
       (VIEW FACTOR -to- SPACE)

    SURFACE        1.-FACT       KEY
```

```
        1.01       0.3965   (   3)
        1.02       0.3648   (  25)
        1.03       0.3930   (  26)
        1.04       0.3858   (  27)
        1.05       0.3524   (  28)
        1.06       0.8752   (   1)
        1.07       0.3811   (   4)
        1.08       0.3527   (  29)
        1.09       0.3855   (  30)
        1.10       0.3854   (  31)
        1.11       0.3524   (  32)
        1.12      -0.0024   (   2)
        2.01       0.6859   (  42)
        2.02       0.8949   (  40)
        2.03       0.9450   (  37)
        2.04       0.9497   (  33)
        2.05       0.8709   (  20)
        2.06       0.5751   (  41)
        2.07       0.7484   (  39)
        2.08       0.7874   (  36)
        2.09       0.7810   (  22)
        2.10       0.7203   (  18)
        3.01       0.7066   (  23)
        3.02       0.8437   (  16)
        3.03       0.8486   (  15)
        3.04       0.7683   (  12)
        3.05       0.7970   (  21)
        3.06       0.9587   (  14)
        3.07       0.9678   (  13)
        3.08       0.8683   (  10)
        4.01      -0.0193   (   8)
        4.02      -0.0115   (   6)
        4.03      -0.0117   (  11)
        4.04      -0.0154   (  19)
        4.05      -0.0348   (  34)
        4.06      -0.0001   (  24)
        4.07      -0.0003   (  35)
        4.08       0.0000   (  38)
        4.09      -0.0171   (   7)
        4.10      -0.0116   (   5)
        4.11      -0.0118   (   9)
        4.12      -0.0112   (  17)
 ACTIVE SURFACES IN OUTPUT-   42
************************************
 VIEW FACTOR CALC CPU TIME (second) =     33.4500
************************************
 ** END OF PC-ITAS VIEW FACTOR CALCULATIONS **
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/
********************************************************************************
Date: 05/20/94                                                  Time: 15:04:58.10
********************************************************************************
================================================================================
                        Script-F Control Parameters
================================================================================
1. SPACE (SINK) Node Number.....................................          0
2. Cutoff Limit For Area*Script-F (Sq.cm.).....................0.5000E+00
3. Cutoff Limit For Blackbody Viewfactors.....................     0.0000
4. SPACE (SINK) Node Emissivity...............................     0.9999
5. SPACE (SINK) Node Temperature (Kelvin).....................     0.0000
```

```
6. SINDA-format RADK file to be generated (Y/N).....          N
7. SINDA Radiation Conductor Number At Start.....       100000
8. Print control: 0:No,do not print, 1:Yes, print all.....    0
9. File name to store RADKs.....................EPS.RAD
================================================================================
```

Seq	Surface No	Node No	Alpha	Emiss	T/Mass	Dissip	Matr ID
1	1.01	1	0.40	0.80	1.00	0.00	0
2	1.02	2	0.40	0.80	1.00	0.00	0
3	1.03	3	0.40	0.80	1.00	0.00	0
4	1.04	4	0.40	0.80	1.00	0.00	0
5	1.05	5	0.40	0.80	1.00	0.00	0
6	1.06	6	0.40	0.80	1.00	0.00	0
7	1.07	7	0.40	0.80	1.00	0.00	0
8	1.08	8	0.40	0.80	1.00	0.00	0
9	1.09	9	0.40	0.80	1.00	0.00	0
10	1.10	10	0.40	0.80	1.00	0.00	0
11	1.11	11	0.40	0.80	1.00	0.00	0
12	1.12	12	0.40	0.80	1.00	0.00	0
13	2.01	13	0.00	0.01	1.00	0.00	0
14	2.02	14	0.00	0.01	1.00	0.00	0
15	2.03	15	0.00	0.01	1.00	0.00	0
16	2.04	16	0.00	0.01	1.00	0.00	0
17	2.05	17	0.00	0.01	1.00	0.00	0
18	2.06	18	0.00	0.01	1.00	0.00	0
19	2.07	19	0.00	0.01	1.00	0.00	0
20	2.08	20	0.00	0.01	1.00	0.00	0
21	2.09	21	0.00	0.01	1.00	0.00	0
22	2.10	22	0.00	0.01	1.00	0.00	0
23	3.01	23	0.00	0.01	1.00	0.00	0
24	3.02	24	0.00	0.01	1.00	0.00	0
25	3.03	25	0.00	0.01	1.00	0.00	0
26	3.04	26	0.00	0.01	1.00	0.00	0
27	3.05	27	0.00	0.01	1.00	0.00	0
28	3.06	28	0.00	0.01	1.00	0.00	0
29	3.07	29	0.00	0.01	1.00	0.00	0
30	3.08	30	0.00	0.01	1.00	0.00	0
31	4.01	31	0.00	0.01	1.00	0.00	0
32	4.02	32	0.00	0.01	1.00	0.00	0
33	4.03	33	0.00	0.01	1.00	0.00	0
34	4.04	34	0.00	0.01	1.00	0.00	0
35	4.05	35	0.00	0.01	1.00	0.00	0
36	4.06	36	0.00	0.01	1.00	0.00	0
37	4.07	37	0.00	0.01	1.00	0.00	0
38	4.08	38	0.00	0.01	1.00	0.00	0
39	4.09	39	0.00	0.01	1.00	0.00	0
40	4.10	40	0.00	0.01	1.00	0.00	0
41	4.11	41	0.00	0.01	1.00	0.00	0
42	4.12	42	0.00	0.01	1.00	0.00	0

```
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
                    *ITAS SCRIPT-F (RADK) COMPUTATIONS*
/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\/\
 PC-ITAS SCRIPT-F CALCULATION SEGMENT:
 Writing ITAS-format RADK for future use
 Node#,     Temp.,     TherMass,     Power
     1       10.00       1.00       0.00 EPS HOUSING
     2       10.00       1.00       0.00 EPS HOUSING
```

3	10.00	1.00	0.00	EPS HOUSING
4	10.00	1.00	0.00	EPS HOUSING
5	10.00	1.00	0.00	EPS HOUSING
6	10.00	1.00	0.00	EPS HOUSING
7	10.00	1.00	0.00	EPS HOUSING
8	10.00	1.00	0.00	EPS HOUSING
9	10.00	1.00	0.00	EPS HOUSING
10	10.00	1.00	0.00	EPS HOUSING
11	10.00	1.00	0.00	EPS HOUSING
12	10.00	1.00	0.00	EPS HOUSING
13	10.00	1.00	0.00	PCB 1-1
14	10.00	1.00	0.00	PCB 1-1
15	10.00	1.00	0.00	PCB 1-1
16	10.00	1.00	0.00	PCB 1-1
17	10.00	1.00	0.00	PCB 1-1
18	10.00	1.00	0.00	PCB 1-1
19	10.00	1.00	0.00	PCB 1-1
20	10.00	1.00	0.00	PCB 1-1
21	10.00	1.00	0.00	PCB 1-1
22	10.00	1.00	0.00	PCB 1-1
23	10.00	1.00	0.00	PCB 1-2
24	10.00	1.00	0.00	PCB 1-2
25	10.00	1.00	0.00	PCB 1-2
26	10.00	1.00	0.00	PCB 1-2
27	10.00	1.00	0.00	PCB 1-2
28	10.00	1.00	0.00	PCB 1-2
29	10.00	1.00	0.00	PCB 1-2
30	10.00	1.00	0.00	PCB 1-2
31	10.00	1.00	0.00	PCB 2 (BOTTOM)
32	10.00	1.00	0.00	PCB 2 (BOTTOM)
33	10.00	1.00	0.00	PCB 2 (BOTTOM)
34	10.00	1.00	0.00	PCB 2 (BOTTOM)
35	10.00	1.00	0.00	PCB 2 (BOTTOM)
36	10.00	1.00	0.00	PCB 2 (BOTTOM)
37	10.00	1.00	0.00	PCB 2 (BOTTOM)
38	10.00	1.00	0.00	PCB 2 (BOTTOM)
39	10.00	1.00	0.00	PCB 2 (BOTTOM)
40	10.00	1.00	0.00	PCB 2 (BOTTOM)
41	10.00	1.00	0.00	PCB 2 (BOTTOM)
42	10.00	1.00	0.00	PCB 2 (BOTTOM)

RAD	00	0.1295000000E+01	1	4
RAD	00	0.3408000000E+01	1	5
RAD	00	0.1231900000E+02	1	6
RAD	00	0.1441000000E+01	1	7
RAD	00	0.1166000000E+01	1	10
RAD	00	0.3754000000E+01	1	11
RAD	00	0.9037000000E+01	1	12
RAD	00	0.5500000000E+00	2	3
RAD	00	0.3313000000E+01	2	6
RAD	00	0.3342000000E+01	2	7
RAD	00	0.2634000000E+01	2	12
RAD	00	0.9950000000E+00	3	4
RAD	00	0.3602000000E+01	3	6
RAD	00	0.9060000000E+00	3	7
RAD	00	0.2767000000E+01	3	12
RAD	00	0.7580000000E+00	4	5
RAD	00	0.3602000000E+01	4	6
RAD	00	0.2770000000E+01	4	12
RAD	00	0.3314000000E+01	5	6
RAD	00	0.2622000000E+01	5	12

```
RAD      00     0.1230000000E+02          6          7
RAD      00     0.3314000000E+01          6          8
RAD      00     0.3600000000E+01          6          9
RAD      00     0.3601000000E+01          6         10
RAD      00     0.3314000000E+01          6         11
RAD      00     0.1643000000E+01          6         12
RAD      00     0.3619000000E+01          7          8
RAD      00     0.1020000000E+01          7          9
RAD      00     0.9591000000E+01          7         12
RAD      00     0.7800000000E+00          8          9
RAD      00     0.2629000000E+01          8         12
RAD      00     0.7910000000E+00          9         10
RAD      00     0.2762000000E+01          9         12
RAD      00     0.2766000000E+01         10         12
RAD      00     0.2615000000E+01         11         12
RAD      00     0.5660000000E+00         12         32
RAD      00     0.5110000000E+00         12         39
RAD      00     0.6110000000E+00         12         40

 #OF RADIATION CONDUCTANCES GENERATED=    38
**********************************
 SCRIPT-F CALC CPU TIME (second)     =     2.64000
**********************************
 ITAS THERMAL ANALYZER:
vvvvvvvvvvvvvvvvvvvv ADDING USER NODES vvvvvvvvvvv
IPTR_N= 5022
RECORD  5022=    1     901    20          0      EPS HOUSING WALLS +X
RECORD  5023=    2     902    20          0      +Y
RECORD  5024=    3     903    20          0      +Y
RECORD  5025=    4     904    20          0      +Y
RECORD  5026=    5     905    20          0      +Y
RECORD  5027=    6     906    20          0      +Z
RECORD  5028=    7     907    20          0      -X
RECORD  5029=    8     908    20          0      -Y
RECORD  5030=    9     909    20          0      -Y
RECORD  5031=   10     910    20          0      -Y
RECORD  5032=   11     911    20          0      -Y
RECORD  5033=   12     912    20          0      -Z
RECORD  5034=   13    -913    40          0      BOUNDARY NODE TO 906
RECORD  5035=   14     921    20          0      HOUSING +Y BOTTOM RAIL
RECORD  5036=   15     922    20          0      +Y MIDDLE RAIL
RECORD  5037=   16     923    20          0      +Y TOP RAIL
RECORD  5038=   17     924    20          0      -Y BOTTOM RAIL
RECORD  5039=   18     925    20          0      -Y MIDDLE RAIL
RECORD  5040=   19     926    20          0      -Y TOP RAIL
RECORD  5041=   20     601    20       .037      TOP PCB THERMAL PLANE
RECORD  5042=   21     602    20       .0475
RECORD  5043=   22     603    20       .01995
RECORD  5044=   23     604    20       .01
RECORD  5045=   24     605    20       .011
RECORD  5046=   25     606    20       .060
RECORD  5047=   26     607    20       .011
RECORD  5048=   27     608    20       0
RECORD  5049=   28     609    20       0
RECORD  5050=   29     610    20       .008
RECORD  5051=   30     611    20       .008
RECORD  5052=   31     612    20       .011
RECORD  5053=   32     613    20       0
RECORD  5054=   33     614    20       0
RECORD  5055=   34     615    20       .009
```

```
RECORD  5056=  35    616   20          .009
RECORD  5057=  36    617   20          .004
RECORD  5058=  37    618   20          0
RECORD  5059=  38    501   20          0       5TH LAYER POLYIMIDE
RECORD  5060=  39    502   20          0
RECORD  5061=  40    503   20          0
RECORD  5062=  41    504   20          0
RECORD  5063=  42    505   20          0
RECORD  5064=  43    506   20          0
RECORD  5065=  44    507   20          0
RECORD  5066=  45    508   20          0
RECORD  5067=  46    509   20          0
RECORD  5068=  47    510   20          0
RECORD  5069=  48    511   20          0
RECORD  5070=  49    512   20          0
RECORD  5071=  50    513   20          0
RECORD  5072=  51    514   20          0
RECORD  5073=  52    515   20          0
RECORD  5074=  53    516   20          0
RECORD  5075=  54    517   20          0
RECORD  5076=  55    518   20
RECORD  5077=  56    401   20          .003    GROUND LAYER  COPPER
RECORD  5078=  57    402   20          .004
RECORD  5079=  58    403   20          .001
RECORD  5080=  59    404   20          .001
RECORD  5081=  60    405   20          0
RECORD  5082=  61    406   20          0
RECORD  5083=  62    407   20          0
RECORD  5084=  63    408   20          0
RECORD  5085=  64    409   20          0
RECORD  5086=  65    410   20          0
RECORD  5087=  66    411   20          0
RECORD  5088=  67    412   20          0
RECORD  5089=  68    413   20          0
RECORD  5090=  69    414   20          0
RECORD  5091=  70    415   20          0
RECORD  5092=  71    416   20          0
RECORD  5093=  72    417   20          0
RECORD  5094=  73    418   20          0
RECORD  5095=  74    301   20          0       3RD LAYER POLYIMIDE
RECORD  5096=  75    302   20          0
RECORD  5097=  76    303   20          0
RECORD  5098=  77    304   20          0
RECORD  5099=  78    305   20          0
RECORD  5100=  79    306   20          0
RECORD  5101=  80    307   20          0
RECORD  5102=  81    308   20          0
RECORD  5103=  82    309   20          0
RECORD  5104=  83    310   20          0
RECORD  5105=  84    311   20          0
RECORD  5106=  85    312   20          0
RECORD  5107=  86    313   20          0
RECORD  5108=  87    314   20          0
RECORD  5109=  88    315   20          0
RECORD  5110=  89    316   20          0
RECORD  5111=  90    317   20          0
RECORD  5112*  91    318   20          0
RECORD  5113*  92    201   20          0       SIGNAL LEVEL (VERY LITTLE CU)
RECORD  5114*  93    202   20          0
RECORD  5115*  94    203   20          0
```

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RECORD  5116=  95    204   20        0
RECORD  5117=  96    205   20        0
RECORD  5118=  97    206   20        0
RECORD  5119=  98    207   20        0
RECORD  5120=  99    208   20        0
RECORD  5121= 100    209   20        0
RECORD  5122= 101    210   20        0
RECORD  5123= 102    211   20        0
RECORD  5124= 103    212   20        0
RECORD  5125= 104    213   20        0
RECORD  5126= 105    214   20        0
RECORD  5127= 106    215   20        0
RECORD  5128= 107    216   20        0
RECORD  5129= 108    217   20        0
RECORD  5130= 109    218   20        0
RECORD  5131= 110    101   20        0     TOP LAYER POLYIMIDE
RECORD  5132= 111    102   20        0
RECORD  5133= 112    103   20        0
RECORD  5134= 113    104   20        0
RECORD  5135= 114    105   20        0
RECORD  5136= 115    106   20        0
RECORD  5137= 116    107   20        0
RECORD  5138= 117    108   20        0
RECORD  5139= 118    109   20        0
RECORD  5140= 119    110   20        0
RECORD  5141= 120    111   20        0
RECORD  5142= 121    112   20        0
RECORD  5143= 122    113   20        0
RECORD  5144= 123    114   20        0
RECORD  5145= 124    115   20        0
RECORD  5146= 125    116   20        0
RECORD  5147= 126    117   20        0
RECORD  5148= 127    118   20        0
RECORD  5149= 128    1601  20     .113  BOTTOM PCB THERMAL PLANE COPPER
RECORD  5150= 129    1602  20     .086
RECORD  5151= 130    1603  20     .025
RECORD  5152= 131    1604  20     0
RECORD  5153= 132    1605  20     0
RECORD  5154= 133    1606  20     .175
RECORD  5155= 134    1607  20     0
RECORD  5156= 135    1608  20     0
RECORD  5157= 136    1609  20     .375
RECORD  5158= 137    1610  20     .105
RECORD  5159= 138    1611  20     .15
RECORD  5160= 139    1612  20     0
RECORD  5161= 140    1613  20     0
RECORD  5162= 141    1614  20     0
RECORD  5163= 142    1615  20     0
RECORD  5164= 143    1616  20     0
RECORD  5165= 144    1617  20     0
RECORD  5166= 145    1618  20     0
RECORD  5167= 146    1501  20     0     5TH LAYER POLYIMIDE
RECORD  5168= 147    1502  20     0
RECORD  5169= 148    1503  20     0
RECORD  5170= 149    1504  20     0
RECORD  5171= 150    1505  20     0
RECORD  5172= 151    1506  20     0
RECORD  5173= 152    1507  20     0
RECORD  5174= 153    1508  20     0
RECORD  5175= 154    1509  20     0
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RECORD  5176= 155   1510  20    0
RECORD  5177= 156   1511  20    0
RECORD  5178= 157   1512  20    0
RECORD  5179= 158   1513  20    0
RECORD  5180= 159   1514  20    0
RECORD  5181= 160   1515  20    0
RECORD  5182= 161   1516  20    0
RECORD  5183= 162   1517  20    0
RECORD  5184= 163   1518  20    0
RECORD  5185= 164   1401  20    0    GROUND LAYER COPPER
RECORD  5186= 165   1402  20    0
RECORD  5187= 166   1403  20    0
RECORD  5188= 167   1404  20    0
RECORD  5189= 168   1405  20    0
RECORD  5190= 169   1406  20    0
RECORD  5191= 170   1407  20    0
RECORD  5192= 171   1408  20    0
RECORD  5193= 172   1409  20    0
RECORD  5194= 173   1410  20    0
RECORD  5195= 174   1411  20    0
RECORD  5196= 175   1412  20    0
RECORD  5197= 176   1413  20    0
RECORD  5198= 177   1414  20    0
RECORD  5199= 178   1415  20    0
RECORD  5200= 179   1416  20    0
RECORD  5201= 180   1417  20    0
RECORD  5202= 181   1418  20    0
RECORD  5203= 182   1301  20    0    3RD LAYER POLYIMIDE
RECORD  5204= 183   1302  20    0
RECORD  5205= 184   1303  20    0
RECORD  5206= 185   1304  20    0
RECORD  5207= 186   1305  20    0
RECORD  5208= 187   1306  20    0
RECORD  5209= 188   1307  20    0
RECORD  5210= 189   1308  20    0
RECORD  5211= 190   1309  20    0
RECORD  5212= 191   1310  20    0
RECORD  5213= 192   1311  20    0
RECORD  5214= 193   1312  20    0
RECORD  5215= 194   1313  20    0
RECORD  5216= 195   1314  20    0
RECORD  5217= 196   1315  20    0
RECORD  5218= 197   1316  20    0
RECORD  5219= 198   1317  20    0
RECORD  5220= 199   1318  20    0
RECORD  5221= 200   1201  20    0    SIGNAL LAYER COPPER
RECORD  5222= 201   1202  20    0
RECORD  5223= 202   1203  20    0
RECORD  5224= 203   1204  20    0
RECORD  5225= 204   1205  20    0
RECORD  5226= 205   1206  20    0
RECORD  5227= 206   1207  20    0
RECORD  5228= 207   1208  20    0
RECORD  5229= 208   1209  20    0
RECORD  5230= 209   1210  20    0
RECORD  5231= 210   1211  20    0
RECORD  5232= 211   1212  20    0
RECORD  5233= 212   1213  20    0
RECORD  5234= 213   1214  20    0
RECORD  5235= 214   1215  20    0
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RECORD  5236= 215    1216  20          0
RECORD  5237= 216    1217  20          0
RECORD  5238= 217    1218  20          0
RECORD  5239= 218    1101  20          0     TOP LAYER POLYIMIDE
RECORD  5240= 219    1102  20          0
RECORD  5241= 220    1103  20          0
RECORD  5242= 221    1104  20          0
RECORD  5243= 222    1105  20          0
RECORD  5244= 223    1106  20          0
RECORD  5245= 224    1107  20          0
RECORD  5246= 225    1108  20          0
RECORD  5247= 226    1109  20          0
RECORD  5248= 227    1110  20          0
RECORD  5249= 228    1111  20          0
RECORD  5250= 229    1112  20          0
RECORD  5251= 230    1113  20          0
RECORD  5252= 231    1114  20          0
RECORD  5253= 232    1115  20          0
RECORD  5254= 233    1116  20          0
RECORD  5255= 234    1117  20          0
RECORD  5256= 235    1118  20          0
^^^^^^^^^^^^^^^^^^^^ END OF USER NODES ^^^^^^^^^^
^^^^^^^^^^^^^^^^^^^^ END OF FLUID ^^^^^^^^^^^^^^^^^^
 TOTAL THERMAL MASS ENCOUNTERED (W-MIN/C)=     1329.04
 TOTAL THERMAL MASS ENCOUNTERED (BTU  /F)=     42.0002
^^^^^^^^^^^^^^^^^^^^ END OF FLUID ^^^^^^^^^^^^^^^^^^
 NODE       1 (REL NODE       1 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       2 (REL NODE       2 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       3 (REL NODE       3 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       4 (REL NODE       4 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       5 (REL NODE       5 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       6 (REL NODE       6 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       7 (REL NODE       7 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       8 (REL NODE       8 ) IS BEING ADDED TO THE CURRENT LIST
 NODE       9 (REL NODE       9 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      10 (REL NODE      10 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      11 (REL NODE      11 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      12 (REL NODE      12 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      13 (REL NODE      13 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      14 (REL NODE      14 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      15 (REL NODE      15 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      16 (REL NODE      16 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      17 (REL NODE      17 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      18 (REL NODE      18 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      19 (REL NODE      19 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      20 (REL NODE      20 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      21 (REL NODE      21 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      22 (REL NODE      22 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      23 (REL NODE      23 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      24 (REL NODE      24 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      25 (REL NODE      25 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      26 (REL NODE      26 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      27 (REL NODE      27 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      28 (REL NODE      28 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      29 (REL NODE      29 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      30 (REL NODE      30 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      31 (REL NODE      31 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      32 (REL NODE      32 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      33 (REL NODE      33 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      34 (REL NODE      34 ) IS BEING ADDED TO THE CURRENT LIST
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 NODE      35 (REL NODE      35 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      36 (REL NODE      36 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      37 (REL NODE      37 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      38 (REL NODE      38 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      39 (REL NODE      39 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      40 (REL NODE      40 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      41 (REL NODE      41 ) IS BEING ADDED TO THE CURRENT LIST
 NODE      42 (REL NODE      42 ) IS BEING ADDED TO THE CURRENT LIST
 END OF RADIATION CONDUCTANCE & POWER PROCESSING
 ITAS THERMAL ANALYSIS:


 CHECKOUT PHASE OF PC-ITAS THERMAL ANALYSIS

 TOTAL CARDS ENCOUNTERED:    1776
 TOTAL THERMAL MASSES USED (W-Min/C)=     1366.04
 TOTAL THERMAL MASSES USED (BTU/F  )=     43.1695
================================================================================
 NO. OF THERMAL NODES=          277

 ITAS STEADY-STATE SOLUTION ALGORITHM (SUCCESSIVE POINT ITERATION) PARAMETERS:
 ARLXCA=0.10000E-02, DRLXCA=0.10000E-02 NLOOP=  9999
********************************************************************************
 ITAS STEADY-STATE SOLUTION (SUCCESSIVE POINT ITERATION)
 NO. OF ITERATIONS= 2805 TOTAL INPUT ENERGY (W)=  1.2830
 SYSTEM ENERGY BALANCE (W)=  7.1385     (  556.39    %)
********************************************************************************
 T     1=     39.68 T     2=     39.43 T     3=     39.39 T     4=     39.40
 T     5=     39.46 T     6=     39.91 T     7=     39.61 T     8=     39.68
 T     9=     39.68 T    10=     39.68 T    11=     39.68 T    12=     39.64
 T    13=     20.18 T    14=     20.43 T    15=     20.66 T    16=     20.73
 T    17=     21.65 T    18=     37.01 T    19=     38.08 T    20=     38.64
 T    21=     39.26 T    22=     39.17 T    23=     39.02 T    24=     39.28
 T    25=     39.27 T    26=     39.43 T    27=     20.59 T    28=     21.00
 T    29=     20.89 T    30=     20.74 T    31=     39.39 T    32=     39.42
 T    33=     39.28 T    34=     38.92 T    35=     21.45 T    36=     22.58
 T    37=     21.48 T    38=     20.84 T    39=     39.71 T    40=     39.43
 T    41=     39.44 T    42=     38.89 T   901=     39.68 T   902=     39.43
 T   903=     39.39 T   904=     39.40 T   905=     39.46 T   906=     39.91
 T   907=     39.61 T   908=     39.68 T   909=     39.68 T   910=     39.68
 T   911=     39.68 T   912=     39.64 T   913=     40.00 T   921=     39.65
 T   922=     39.65 T   923=     39.74 T   924=     39.64 T   925=     39.67
 T   926=     39.74 T   601=     39.02 T   602=     39.28 T   603=     39.27
 T   604=     39.43 T   605=     20.59 T   606=     21.00 T   607=     20.89
 T   608=     20.74 T   609=     20.18 T   610=     20.43 T   611=     20.66
 T   612=     20.73 T   613=     21.65 T   614=     37.01 T   615=     38.08
 T   616=     38.64 T   617=     39.26 T   618=     39.17 T   501=     36.53
 T   502=     36.72 T   503=     36.78 T   504=     37.12 T   505=     24.43
 T   506=     24.72 T   507=     24.88 T   508=     25.64 T   509=     24.60
 T   510=     24.85 T   511=     24.98 T   512=     24.88 T   513=     25.99
 T   514=     34.27 T   515=     34.75 T   516=     35.15 T   517=     35.89
 T   518=     35.74 T   401=     34.13 T   402=     34.21 T   403=     34.35
 T   404=     34.86 T   405=     28.19 T   406=     28.39 T   407=     28.81
 T   408=     30.38 T   409=     28.86 T   410=     29.04 T   411=     29.13
 T   412=     28.93 T   413=     30.18 T   414=     31.66 T   415=     31.63
 T   416=     31.80 T   417=     32.62 T   418=     32.45 T   301=     34.64
 T   302=     34.73 T   303=     34.85 T   304=     35.41 T   305=     28.19
 T   306=     28.39 T   307=     28.81 T   308=     30.38 T   309=     28.86
 T   310=     29.04 T   311=     29.13 T   312=     28.93 T   313=     30.18
 T   314=     32.73 T   315=     32.76 T   316=     32.83 T   317=     33.56
```

T	318=	33.43	T	201=	35.16	T	202=	35.24	T	203=	35.34
T	204=	35.97	T	205=	28.19	T	206=	28.39	T	207=	28.81
T	208=	30.38	T	209=	28.86	T	210=	29.04	T	211=	29.13
T	212=	28.93	T	213=	30.18	T	214=	33.81	T	215=	33.90
T	216=	33.86	T	217=	34.50	T	218=	34.40	T	101=	35.68
T	102=	35.75	T	103=	35.84	T	104=	36.53	T	105=	28.19
T	106=	28.39	T	107=	28.81	T	108=	30.38	T	109=	28.86
T	110=	29.04	T	111=	29.13	T	112=	28.93	T	113=	30.18
T	114=	34.89	T	115=	34.28	T	116=	34.89	T	117=	35.44
T	118=	35.37	T	1601=	39.39	T	1602=	39.42	T	1603=	39.28
T	1604=	38.92	T	1605=	21.45	T	1606=	22.58	T	1607=	21.48
T	1608=	20.84	T	1609=	39.71	T	1610=	39.43	T	1611=	39.44
T	1612=	38.89	T	1613=	20.00	T	1614=	20.00	T	1615=	20.00
T	1616=	20.00	T	1617=	20.00	T	1618=	20.00	T	1501=	38.37
T	1502=	38.38	T	1503=	38.25	T	1504=	38.02	T	1505=	28.27
T	1506=	28.85	T	1507=	28.23	T	1508=	27.91	T	1509=	38.52
T	1510=	38.34	T	1511=	38.28	T	1512=	37.94	T	1513=	20.00
T	1514=	20.00	T	1515=	20.00	T	1516=	20.00	T	1517=	20.00
T	1518=	20.00	T	1401=	37.38	T	1402=	37.38	T	1403=	37.26
T	1404=	37.17	T	1405=	34.89	T	1406=	34.97	T	1407=	34.75
T	1408=	34.63	T	1409=	37.36	T	1410=	37.28	T	1411=	37.17
T	1412=	37.04	T	1413=	20.00	T	1414=	20.00	T	1415=	20.00
T	1416=	20.00	T	1417=	20.00	T	1418=	20.00	T	1301=	37.55
T	1302=	37.54	T	1303=	37.43	T	1304=	37.34	T	1305=	34.89
T	1306=	34.97	T	1307=	34.75	T	1308=	34.63	T	1309=	37.53
T	1310=	37.46	T	1311=	37.35	T	1312=	37.23	T	1313=	20.00
T	1314=	20.00	T	1315=	20.00	T	1316=	20.00	T	1317=	20.00
T	1318=	20.00	T	1201=	37.71	T	1202=	37.71	T	1203=	37.60
T	1204=	37.51	T	1205=	34.89	T	1206=	34.97	T	1207=	34.75
T	1208=	34.63	T	1209=	37.71	T	1210=	37.64	T	1211=	37.54
T	1212=	37.42	T	1213=	20.00	T	1214=	20.00	T	1215=	20.00
T	1216=	20.00	T	1217=	20.00	T	1218=	20.00	T	1101=	37.88
T	1102=	37.87	T	1103=	37.77	T	1104=	37.68	T	1105=	34.89
T	1106=	34.97	T	1107=	34.75	T	1108=	34.63	T	1109=	37.88
T	1110=	37.82	T	1111=	37.73	T	1112=	37.61	T	1113=	20.00
T	1114=	20.00	T	1115=	20.00	T	1116=	20.00	T	1117=	20.00
T	1118=	20.00	T								

ASCENDING NODE NUMBER : TEMPERATURE

****

ITAS STEADY-STATE SOLUTION (SUCCESSIVE POINT ITERATION)
NO. OF ITERATIONS= 2805 TOTAL INPUT ENERGY (W)= 1.2830
SYSTEM ENERGY BALANCE (W)= 7.1385 (556.39 %)

****

T	1=	39.676	T	2=	39.432	T	3=	39.392	T	4=	39.400
T	5=	39.458	T	6=	39.911	T	7=	39.612	T	8=	39.684
T	9=	39.684	T	10=	39.684	T	11=	39.684	T	12=	39.642
T	13=	20.181	T	14=	20.433	T	15=	20.655	T	16=	20.725
T	17=	21.649	T	18=	37.012	T	19=	38.079	T	20=	38.644
T	21=	39.252	T	22=	39.168	T	23=	39.018	T	24=	39.278
T	25=	39.272	T	26=	39.428	T	27=	20.586	T	28=	20.996
T	29=	20.890	T	30=	20.740	T	31=	39.393	T	32=	39.417
T	33=	39.280	T	34=	38.924	T	35=	21.450	T	36=	22.584
T	37=	21.483	T	38=	20.843	T	39=	39.710	T	40=	39.425
T	41=	39.436	T	42=	38.892	T	101=	35.675	T	102=	35.753
T	103=	35.841	T	104=	36.526	T	105=	28.187	T	106=	28.391
T	107=	28.807	T	108=	30.378	T	109=	28.861	T	110=	29.042
T	111=	29.133	T	112=	28.932	T	113=	30.184	T	114=	34.890
T	115=	34.280	T	116=	34.889	T	117=	35.438	T	118=	35.374
T	201=	35.159	T	202=	35.240	T	203=	35.344	T	204=	35.969

T	205=	28.187	T	206=	28.391	T	207=	28.807	T	208=	30.378
T	209=	28.861	T	210=	29.042	T	211=	29.133	T	212=	28.932
T	213=	30.184	T	214=	33.812	T	215=	33.901	T	216=	33.860
T	217=	34.498	T	218=	34.400	T	301=	34.643	T	302=	34.727
T	303=	34.847	T	304=	35.412	T	305=	28.188	T	306=	28.391
T	307=	28.808	T	308=	30.378	T	309=	28.861	T	310=	29.042
T	311=	29.133	T	312=	28.932	T	313=	30.184	T	314=	32.735
T	315=	32.764	T	316=	32.831	T	317=	33.557	T	318=	33.427
T	401=	34.127	T	402=	34.214	T	403=	34.351	T	404=	34.855
T	405=	28.188	T	406=	28.391	T	407=	28.808	T	408=	30.378
T	409=	28.861	T	410=	29.042	T	411=	29.133	T	412=	28.932
T	413=	30.185	T	414=	31.658	T	415=	31.627	T	416=	31.803
T	417=	32.616	T	418=	32.454	T	501=	36.526	T	502=	36.716
T	503=	36.783	T	504=	37.115	T	505=	24.432	T	506=	24.721
T	507=	24.878	T	508=	25.637	T	509=	24.597	T	510=	24.847
T	511=	24.976	T	512=	24.881	T	513=	25.989	T	514=	34.275
T	515=	34.749	T	516=	35.149	T	517=	35.891	T	518=	35.740
T	601=	39.019	T	602=	39.278	T	603=	39.272	T	604=	39.428
T	605=	20.586	T	606=	20.996	T	607=	20.891	T	608=	20.740
T	609=	20.181	T	610=	20.433	T	611=	20.656	T	612=	20.726
T	613=	21.650	T	614=	37.013	T	615=	38.079	T	616=	38.644
T	617=	39.259	T	618=	39.168	T	901=	39.676	T	902=	39.432
T	903=	39.392	T	904=	39.401	T	905=	39.458	T	906=	39.911
T	907=	39.612	T	908=	39.685	T	909=	39.685	T	910=	39.685
T	911=	39.684	T	912=	39.642	T	913=	40.000	T	921=	39.649
T	922=	39.650	T	923=	39.739	T	924=	39.642	T	925=	39.667
T	926=	39.740	T	1101=	37.875	T	1102=	37.871	T	1103=	37.773
T	1104=	37.683	T	1105=	34.893	T	1106=	34.966	T	1107=	34.751
T	1108=	34.628	T	1109=	37.882	T	1110=	37.822	T	1111=	37.727
T	1112=	37.613	T	1113=	20.000	T	1114=	20.000	T	1115=	20.000
T	1116=	20.000	T	1117=	20.000	T	1118=	20.000	T	1201=	37.711
T	1202=	37.707	T	1203=	37.603	T	1204=	37.511	T	1205=	34.893
T	1206=	34.966	T	1207=	34.751	T	1208=	34.628	T	1209=	37.708
T	1210=	37.642	T	1211=	37.540	T	1212=	37.423	T	1213=	20.000
T	1214=	20.000	T	1215=	20.000	T	1216=	20.000	T	1217=	20.000
T	1218=	20.000	T	1301=	37.547	T	1302=	37.543	T	1303=	37.432
T	1304=	37.340	T	1305=	34.894	T	1306=	34.966	T	1307=	34.751
T	1308=	34.629	T	1309=	37.533	T	1310=	37.462	T	1311=	37.353
T	1312=	37.233	T	1313=	20.000	T	1314=	20.000	T	1315=	20.000
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T	1402=	37.379	T	1403=	37.261	T	1404=	37.169	T	1405=	34.894
T	1406=	34.967	T	1407=	34.752	T	1408=	34.629	T	1409=	37.359
T	1410=	37.283	T	1411=	37.167	T	1412=	37.043	T	1413=	20.000
T	1414=	20.000	T	1415=	20.000	T	1416=	20.000	T	1417=	20.000
T	1418=	20.000	T	1501=	38.371	T	1502=	38.383	T	1503=	38.252
T	1504=	38.016	T	1505=	28.272	T	1506=	28.850	T	1507=	28.225
T	1508=	27.912	T	1509=	38.516	T	1510=	38.339	T	1511=	38.280
T	1512=	37.936	T	1513=	20.000	T	1514=	20.000	T	1515=	20.000
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T	1602=	39.417	T	1603=	39.280	T	1604=	38.925	T	1605=	21.450
T	1606=	22.585	T	1607=	21.484	T	1608=	20.844	T	1609=	39.711
T	1610=	39.426	T	1611=	39.436	T	1612=	38.893	T	1613=	20.000
T	1614=	20.000	T	1615=	20.000	T	1616=	20.000	T	1617=	20.000
T	1618=	20.000	T								

ASCENDING NODE NUMBER : IMPRESSED Q

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Q	5=	0.000	Q	6=	0.000	Q	7=	0.000	Q	8=	0.000
Q	9=	0.000	Q	10=	0.000	Q	11=	0.000	Q	12=	0.000
Q	13=	0.000	Q	14=	0.000	Q	15=	0.000	Q	16=	0.000
Q	17=	0.000	Q	18=	0.000	Q	19=	0.000	Q	20=	0.000

Q	21=	0.000	Q	22=	0.000	Q	23=	0.000	Q	24=	0.000
Q	25=	0.000	Q	26=	0.000	Q	27=	0.000	Q	28=	0.000
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Q	41=	0.000	Q	42=	0.000	Q	101=	0.000	Q	102=	0.000
Q	103=	0.000	Q	104=	0.000	Q	105=	0.000	Q	106=	0.000
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Q	111=	0.000	Q	112=	0.000	Q	113=	0.000	Q	114=	0.000
Q	115=	0.000	Q	116=	0.000	Q	117=	0.000	Q	118=	0.000
Q	201=	0.000	Q	202=	0.000	Q	203=	0.000	Q	204=	0.000
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Q	209=	0.000	Q	210=	0.000	Q	211=	0.000	Q	212=	0.000
Q	213=	0.000	Q	214=	0.000	Q	215=	0.000	Q	216=	0.000
Q	217=	0.000	Q	218=	0.000	Q	301=	0.000	Q	302=	0.000
Q	303=	0.000	Q	304=	0.000	Q	305=	0.000	Q	306=	0.000
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Q	311=	0.000	Q	312=	0.000	Q	313=	0.000	Q	314=	0.000
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Q	405=	0.000	Q	406=	0.000	Q	407=	0.000	Q	408=	0.000
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Q	413=	0.000	Q	414=	0.000	Q	415=	0.000	Q	416=	0.000
Q	417=	0.000	Q	418=	0.000	Q	501=	0.000	Q	502=	0.000
Q	503=	0.000	Q	504=	0.000	Q	505=	0.000	Q	506=	0.000
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Q	605=	0.011	Q	606=	0.060	Q	607=	0.011	Q	608=	0.000
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Q	617=	0.004	Q	618=	0.000	Q	901=	0.000	Q	902=	0.000
Q	903=	0.000	Q	904=	0.000	Q	905=	0.000	Q	906=	0.000
Q	907=	0.000	Q	908=	0.000	Q	909=	0.000	Q	910=	0.000
Q	911=	0.000	Q	912=	0.000	Q	913=	0.000	Q	921=	0.000
Q	922=	0.000	Q	923=	0.000	Q	924=	0.000	Q	925=	0.000
Q	926=	0.000	Q	1101=	0.000	Q	1102=	0.000	Q	1103=	0.000
Q	1104=	0.000	Q	1105=	0.000	Q	1106=	0.000	Q	1107=	0.000
Q	1108=	0.000	Q	1109=	0.000	Q	1110=	0.000	Q	1111=	0.000
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Q	1116=	0.000	Q	1117=	0.000	Q	1118=	0.000	Q	1201=	0.000
Q	1202=	0.000	Q	1203=	0.000	Q	1204=	0.000	Q	1205=	0.000
Q	1206=	0.000	Q	1207=	0.000	Q	1208=	0.000	Q	1209=	0.000
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Q	1512=	0.000	Q	1513=	0.000	Q	1514=	0.000	Q	1515=	0.000
Q	1516=	0.000	Q	1517=	0.000	Q	1518=	0.000	Q	1601=	0.113

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 Q  1610=      0.105 Q  1611=      0.150 Q  1612=      0.000 Q  1613=      0.000
 Q  1614=      0.000 Q  1615=      0.000 Q  1616=      0.000 Q  1617=      0.000
 Q  1618=      0.000 Q
**************************************
 THERMAL CALC CPU TIME (second)     =     100.790
**************************************
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LIST OF REFERENCES

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